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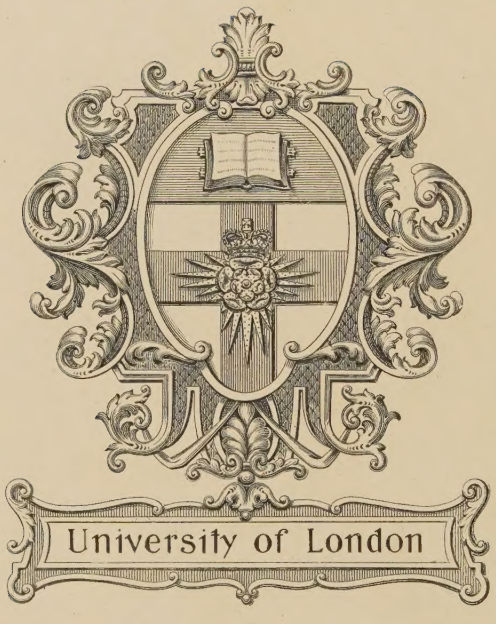

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REPORT

OF

THE COMMISSIONERS

UPON THE SUBJECT OF

HARBOURS OF REFUGE.

Presented to The House of Commons, *in pursuance of an Address, dated 6th March,* 1845.

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1845.

advantages which the several situations which they may recommend would respectively possess, and to which of them, on the whole, they would give the preference.

My Lords will transmit to the Commissioners the several Reports which contain the result of previous investigations into this subject; and they doubt not that the Commissioners will fully consider the bearing of the evidence which has been already adduced, and will call for such further evidence as it appears to them desirable to obtain before forming their final judgment upon this important subject.

My Lords will be prepared to defray any expenses which may be necessariiv incurred by the Commissioners in prosecuting their inquiries, upon the accounts being forwarded to this office; an adequate remuneration being included for a Secretary, in case the Commissioners should deem the assistance of a Secretary requisite; in which case the appointment of a Secretary would be left to the Commissioners.

My Lords will also take care that rooms shall be provided for the Commissioners when they may meet in London.

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REPORT.

TO THE RIGHT HONOURABLE THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

Report.

We, the undersigned Harbour Commissioners, appointed by your Lordships' Minute, of the 2nd of April last, whose names are hereunto subscribed, have the honour to report to your Lordships the result of our proceedings in pursuance of the objects pointed out to us in that Minute.

Preliminary Remarks.

We entered upon our important and difficult duties with a deep sense of the responsibility under which we should have to offer our opinions.

This feeling lost nothing of its force during our visit to the south-east coast, nor is it diminished on a review of the circumstances under which we have now to present for your Lordships' consideration, proposals, which if approved, must necessarily trespass largely on the public revenue.

Treasury Minute.

The Treasury Minute, under which we act, gives, for our guidance, three principal objects, viz.

First. The formation of Ports of Refuge for the safety and convenience of vessels navigating the British channel.

Secondly. That these should be calculated to become, in the event of hostilities, the stations for ships of war.

Thirdly. The consideration of expense as compared with the public advantages likely to result from the construction of such works.

No specific limits.

Our instructions do not bind us by any strictly specific limits. We are told, "If we think one harbour in the channel is not sufficient, we are at liberty to "extend our inquiries accordingly."

We availed ourselves of the scope thus given to us, and being unanimously of opinion that one harbour would not be sufficient, we proceeded to the extreme west of the narrow part of the channel at Portland; and eastward to Harwich, which, though not strictly within the limits of the channel, is on the south-east coast, and forms an important termination to our line in that direction. Any less comprehensive view of the coast would have fallen short of the spirit of your Lordships' instructions.

The surveyors placed at our disposal by the Admiralty, were directed to make detailed surveys of the anchoring ground at each place, and also to ascertain if any change had occurred since the publication of the last charts.

Requisite Surveys made.

This service has been admirably performed by Captain Washington and the officers of Her Majesty's surveying vessel the *Blazer*, at the eastern ports, and at Portland, with equal skill, by Commander Sheringham and the officers of the *Fearless* surveying vessel.

Assistance from Admiralty, &c.

Throughout our proceedings we have received unlimited assistance from the Lords Commissioners of the Admiralty, and, amongst other advantages, their Lordships have permitted us to refer, as occasion required, to their hydrographer, Captain Beaufort, whose ready help has been most useful.

We obtained every information we could desire from the officers of the Cinque Ports, from the officers of the Royal Engineers, the collectors of customs, and from the officers of the Coast Guard.

The Report of the "Select Committee of the House of Commons on Ship-"wrecks" to which we are referred by your Lordships, has been read by each member of the Commission, and the copious information contained in that volume is well worthy the attention of all who may at any time be engaged in considering matters relating to the ports and maritime interests of the kingdom.

Plans and Proposals examined.

It was not to be supposed that an inquiry of such a nature as the construction of harbours could be entered on without bringing forward many intelligent

REPORT.

persons with propositions of various kinds; and the Appendix shows their names, and the nature of their proposals.

To each individual we have given a patient hearing, as our Minutes of Examination fully testify; and every fair consideration has been bestowed on their plans.

Evidence of Shipping Interest.

We invited the Chairman of Lloyds and the Chairman of the Ship Owner's Society to meet us, or to delegate others, to state the opinions of those great mercantile bodies, with reference to the positions they consider best as ports for the shelter of the trade.

Evidence at the different Ports.

We have also had before us every class of persons who were thought capable of affording information, including several eminent engineers; and, in order to guard against the often misleading opinions of residents at the different ports, we have examined many others, practically acquainted with the various places, whom we believed to be unbiassed by local partialities.

The examination of persons so varied in their pursuits could not but afford much useful information; it has however been no light task to deal with the conflicting opinions they offer.

With these preliminary remarks, we proceed to lay before your Lordships the result of our deliberate consideration of the whole of the circumstances which have earnestly occupied our attention.

FORENESS.

Foreness near Margate.

We proceeded, in the first instance, to Foreness, near the North Foreland, the site which the Harbour Commission of 1840 recommended as the place third in importance for an artificial harbour, giving a preference, first to Dover, and secondly to Beachy Head.

It is right to name the persons who composed that Commission,* in order that their opinions may have the influence justly due to the high distinction they hold in their different professions.

Commission of 1840.

The Commission of 1840 had specific limits assigned to its operations; namely, "To visit the coast between the mouth of the Thames and Selsea Bill; "to examine the ports with reference to their being available as places of shelter "for vessels passing through the Channel in cases of distress from weather, and "also as places of refuge for merchant vessels from enemies' cruizers, in time of "war; and more especially as to their being made stations for armed steamers "employed for the protection of our trade in the narrow parts of the Channel."

We quote this instruction both with reference to what we have to state respecting Foreness, and to other matters we shall have to mention in the course of our Report.

Position of Foreness.

Foreness stands well in the fairway of the traffic between the Thames and the Downs, and would, no doubt, if converted into a harbour, frequently prove to be a very convenient anchorage for outward-bound vessels, caught off the Foreland by strong south-west gales, and for homeward-bound ships meeting with adverse winds.

The Commission of 1840 give weight to their proposal in favour of Foreness by observing that a harbour there "must be regarded as one of refuge for vessels "navigating or stationed in the North Sea;" but, if their instructions had not precluded them from the consideration of Harwich, we think they would have suggested the improvement of that splendid natural harbour at a small expense, rather than have proposed a large outlay of money in constructing one at Foreness.

Superior position of Harwich.

Nothing can be more manifest than the fact that Harwich, as far as position goes (being actually on the shores of the North Sea), is the proper place for a squadron of steamers on that station, as well as for a Harbour of Refuge for merchant ships; while the neighbouring anchorage in Hollesley Bay is favourably suited for ships of the line.

Foreness not recommended.

On this account it seems to us unnecessary to construct a harbour at Foreness; and we think the Commission of 1840 would have taken the same view of the subject if Harwich had come within their examination.

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* Rear-Admiral Sir James Gordon, K.C.B.; Captain Vidal, Admiralty Surveyor, now commanding Her Majesty's surveying vessel the Styx; Lieut.-Colonel Thompson, Royal Engineers; Captain Drew, an elder brother of the corporation of the Trinity House; James Walker, Esq., and William Cubitt, Esq., civil engineers.

RAMSGATE.

Our next visit was to the port of Ramsgate, a mere creek in 1748, but now of such capacity that, in the last three years, the number of vessels which arrived in that harbour amounted on an average to 1600 sail a-year, exclusive of fishing craft, town hoys, and the daily voyages of steamers. Utility of Ramsgate Harbour.

Ramsgate Harbour is kept clear partly by its back-water; and, if ever the basin at the west end, designed by the late Mr. Rennie, be carried into execution, it will give increased power of backwater, and enable the port to receive many more ships.

The improvement of Ramsgate Harbour is the result of vigorous efforts by the managing trustees; and their success, which cannot be too highly appreciated, is forcibly exhibited by contrasting its present increased utility with the facts stated by the celebrated Smeaton, who says that the number of vessels that entered the harbour in the year— Improvement of the Harbour.

"1780	amounted to	29	sail."
1785	„	215	
1790	„	387	

whereas, in the three last years, it appears on the evidence of the harbour master, there arrived in the port, in—

1841	1543	Average, 1600 sail.
1842	1652	
1843	1606	

Of the number of vessels that arrived in 1843, 31 gave an average of 457 tons each; and when it is recollected that more than two-thirds of the trade of Great Britain is carried on in vessels under 400 tons, it shews the advantage the mercantile marine derives from this port in connection with the Downs. Great increase Trade.

The harbour-master states that, in the winter of 1832, there were, at one time, 434 sail in the port; and if the additional basin before alluded to at the west end be made, there will be room for upwards of 600 sail.

It will be an improvement if the approaches and entrance to the harbour can be deepened by the use of dredging vessels, or other means applicable to the purpose. Approaches should be deepened.

THE BRAKE, OR SMALL DOWNS.

The next place we have to notice is "The Brake," within which is the anchorage called the "Small Downs." Situation.

It is here that a harbour has been proposed by Sir John Henry Pelly, Deputy Master of the Corporation of the Trinity House, one of the Committee of Management of Ramsgate Harbour, and a member of this Commission.

Any suggestion of this nature, coming from such a quarter, could not fail to engage our best attention.

The "Small Downs" is an anchorage of considerable extent, lying between the Brake Sand and the shore, northward of Deal. The holding-ground is good, and it is the general anchorage of the smaller class of merchant vessels having occasion to bring up in the Downs, thus leaving the Great Downs more clear for ships of larger draught of water. Small Downs.

The Brake Sand is about five miles in length, with a depth upon it at low water, spring tides, of from 3 to 12 feet. It shelters the Small Downs from the east, in the same way that the Goodwin Sand shelters the whole of the Downs for a distance of nine miles.

We have had before us an elaborate plan, and a very full report addressed to the trustees of Ramsgate Harbour respecting a design, prepared by Sir John Rennie, by which it appears that the breakwater he proposes to construct is to be five miles in length, at an estimated cost of 3,280,000*l*. Proposal of Sir John Rennie.

This plan is to convert the Small Downs into a close harbour by constructing a solid work along the spine of the Brake, to be brought up two feet above the high-water mark.

REPORT.

There is, however, a modified suggestion of Sir John Rennie, which if adopted, would reduce the cost to about 1,300,000*l.*

Proposal of Captain Vetch. See Appendix.

Another proposition was submitted to us for a work on the Brake Sand, by Captain Vetch, late of the Royal Engineers, by which he proposes to make a sheltered anchorage within the Brake at a cost of 850,000*l.*

Proposal of Sir S. Brown.

A third by Captain Sir Samuel Brown, R.N., also for the Brake, the details of which will be found in the Evidence.

Shifting of the Brake Sand.

It has lately been shown by an Admiralty Surveyor, Captain Bullock, that the Brake Sand has gone about 700 yards bodily in shore.

The Trinity House, on obtaining the survey from the Admiralty, shifted the south and middle Brake Buoys, and issued a printed notice to all mariners of this remarkable change.

Opinion of Commission of 1810.

The Commission of 1840, which included the late Captain Drew, one of the most able men of the Trinity House, say, in reference to the "expediency of enclosing the Small Downs," that "the magnitude and extent of such a work, which would require a breakwater and pier of upwards of five miles in length, the small depth of water at the northern entrance, and the uncertain nature of the foundation, induce us to abandon the idea of a Harbour of Refuge at that place."

According to the spirit of your Lordships' instructions, and strictly in conformity with those issued by the Admiralty to the former Commission, we have in preference directed our attention to the narrow part of the Channel where the navigation is dangerous to ships contending with adverse winds, and where in war the risk of capture would be greatest; it is there that we are to provide harbours of refuge for merchant ships, and suitable ports to enable our vessels of war to maintain their stations in order to give protection to the passing trade.

A harbour in the Downs can only be for ships that have actually passed all the risks of the narrow part of the Channel, or for ships waiting to commence their voyage.

Not authorized to recommend it.

For these reasons, and considering the Downs in its present state an excellent roadstead, with Ramsgate Harbour immediately adjoining, capable of containing at one time upwards of 400 sail, and which may be made to receive 200 sail more, we do not feel ourselves warranted in proposing any outlay of the public money in the Downs.

DOVER.

Importance of Dover in history.

History affords proof of the importance attached to this place as a military and naval station.

As the advanced post of England on the south-east coast, the want of a harbour here of sufficient capacity for the reception of vessels of war, and for the convenience and protection of trade, has attracted the notice of sovereigns and ministers from the earliest times, and has led to a large expenditure of money for the improvement of the present tidal harbour.

In considering positions eligible for the construction of breakwaters, it should be borne in mind that an inner harbour is an indispensable requisite, and if there is no natural advantage of that sort in the position selected, there must be the double operation of building an inner as well as an outer harbour.

Advantages of inside Harbour.

There are few places that in this respect possess greater advantages than Dover. It has a dry dock for repairs, and extensive quays, with storehouses. Besides the outer receiving harbour, there is a basin covering more than six acres (now being enlarged to double that size), and a third called the Pent, which the late Mr. Rennie, in his Report to Mr. Pitt, in 1802, says, may of itself be made capable of receiving many sloops-of-war and gun-brigs, and which the Dover Commissioners are now considerably improving.

Mr. Pitt desirous of a Breakwater at Dover.

Mr. Pitt, when Lord Warden of the Cinque Ports, was earnestly intent on having Dover Bay enclosed, and it was this circumstance which led to our obtaining from the Master-General of the Ordnance the plan of a harbour in Dover Bay,

General Ford's Plan.

by the late Major-General Ford, of the Royal Engineers.

Objections to Dover stated.

There are two points, each of great importance, which have been suggested as objections to any proposal for converting Dover Bay into a harbour; one that the holding ground is not good, the other that it will have a tendency to silt up.

Proof of good holding ground in Dover Bay.

With respect to the quality of the anchoring ground, Her Majesty's steam-vessel, the *Blazer*, of 500 tons and 120-horse power, was ordered there to test its tenacity to the utmost. The nature of the experiments and the satisfactory result will be seen in Captain Washington's Report in the Appendix.

In reference to the question of silting up, the Commission directed samples of the water in Dover Bay to be taken up at different times of tide, in different depths, and under varying circumstances of weather, which have been transmitted to the Director of the Museum of Economic Geology for examination; the results, as reported by Mr. Phillips, will be found in the Appendix.

Examination of Dover Bay water.

The Commission is of opinion that more extensive experiments are necessary in order to determine the quantities of matter borne in suspension by the tidal currents on this part of the coast and liable to deposit, and beg therefore to suggest to your Lordships the propriety of their being continued, under the direction of the Admiralty, for the space of a year, in all circumstances of weather.

More experiments recommended.

Dover, situated at a distance of only four miles and a half from the Goodwin Sands, and standing out favourably to protect the navigation of the narrow seas, is naturally the situation for a squadron of ships of war. Its value in a military point of view is undoubted; but the construction of a Harbour of Refuge there, is, in our opinion, indispensable, to give to Dover that efficiency as a naval station which is necessary in order to provide for the security of this part of the coast, and the protection of trade.

Dover favourably situated.

DUNGENESS.

This place is a singular formation of shingle, spreading over a space of several miles, stretching out seaward into the fair way of the channel, and having at its termination deep water close to the beach. It is without buildings except the lighthouse and several batteries, the barracks of which are occupied by the Coast Guard.

Position of Dungeness.

The point of Dungeness has lengthened out considerably since the present lighthouse was built in 1792. There is an inscription within the tower, by which it appears that, at the time it was built, the sea was at a distance of 100 yards at low water. We, on our visit to that place, measured it, and found it to be about 190 yards, showing that it has lengthened out 90 yards in 52 years.

Increase of point.

It is to be regretted that no periodical account has been kept of the lengthening out of the point, which, if it had been taken every year, and registered in the lighthouse, would have afforded information of great importance, and would have shewn whether the rate of elongation has been uniform or otherwise. The Commission consider it very desirable that an accurate record be preserved hereafter of all alterations of Dungeness Point and its immediate vicinity, of its annual extension seaward, of the effect of great storms upon it, and generally of the movement of the shingle. For this purpose the Commission beg to suggest that the Admiralty, in conjunction with the Trinity House, be requested to give directions on the subject.

Should be measured periodically.

Dungeness has ever been remarkable for its good holding-ground. Both Bays afford excellent and extensive anchorage, according to the state of the wind. It is in evidence that upwards of 300 sail have been well sheltered in the East Bay at one time, and that more than 100 vessels were at anchor in the West Bay a few days before the Commission arrived there. Where nature presents so much accommodation and shelter, it will always be a matter for serious consideration whether it may not be well to be satisfied with what is already so good, and to give to other places of acknowledged importance in point of position, the artificial assistance they need, in order to render them available as places of secure anchorage.

Good holding ground.

Dungeness does not possess the advantage of an inner harbour, as Dover, Seaford, and Portland; this, however, takes nothing from its value as a roadstead for merchantmen and for ships of war.

Has no harbour.

Having come to the conclusion that it is not expedient to construct a breakwater at Dungeness, we do not advert in detail to what has appeared in evidence as to the effects which such a work would be likely to produce on the lengthening or otherwise, of the point; and on the anchorage in the East and West Bays; but we refer to the opinions of several eminent civil engineers touching the advantages of this important place.

BEACHY HEAD, EAST BOURNE, AND SEAFORD.

We have now to draw your Lordships' attention to the bay on the east side of Beachy Head, and westward of Langley point, which the Commission of 1840 proposed as a site for a breakwater.

East Bourne Bay

REPORT.

Recent survey.

The shoals called the Royal Sovereign, and others, as laid down in the Admiralty Chart, first attracted our notice with reference to this work; it was, therefore, thought desirable to have a more detailed and extended examination of the bay by the surveying vessel placed at our disposal by the Admiralty.

Much shoal water.

The result has been the discovery of several other patches of shoal water, as shown in the accompanying chart, and our previous impression as to the hazard of placing a harbour of refuge in such a situation, has been so strengthened that we decided to look for a more eligible one on the west side of the Head. There is no inner harbour or opening along the coast on the east side of Beachy Head.

Seaford Road.

On the west side of Beachy Head the anchorage is free from the dangers which render the east side less eligible as a place for constructing a harbour of refuge. The holding ground off Seaford is of the best quality, and is much resorted to in easterly gales.

The Commission is of opinion that there is no good position in the neighbourhood of Beachy Head, where a harbour is as necessary as in any part of the Channel, (being about half way between Dover and Portsmouth,) except in Seaford Road, and the accompanying chart shows the place where a breakwater may be constructed with great advantage to the trade, and as a station for armed vessels.

The Commission are fully aware of the objections which may be made to the formation of a breakwater harbour on the west side of Beachy Head, considering the prevalence of the westerly wind; but the local disadvantages on the east side of the Head, induce them to give a decided preference to the west side, and the proximity of Newhaven has materially influenced their decision

NEWHAVEN.

Newhaven a convenient tidal harbour.

Newhaven is a convenient tidal harbour, and may be considerably improved inwardly, as well as by carrying out a breakwater from "Barrow Head" into a depth of three fathoms at low-water spring-tides; by advancing the piers seaward, giving a wider entrance, and dredging the channel enclosed between them; but as it cannot be made accessible at all times of tide, it does not come within the scope of our instructions to recommend any present outlay of the public money for this purpose.

May be improved.

It will be the interest of the Commissioners of the Upper and Lower Ouse to apply their revenues to the utmost advantage, so as to give increased facilities of access to the harbour should a breakwater be constructed in its vicinity.

PORTLAND AND WEYMOUTH.

Position of Portland

Our next and last visit westward was to Portland, which, from its situation with reference to the Channel Islands, and as the boundary of the narrow part of the Channel in this direction, came naturally within the range of our investigation.

A squadron stationed at Portland will have under its protection, jointly with Dartmouth, all the intervening coast, and these places, with Plymouth, will complete the chain of communication and co-operation between Dover and Falmouth, a distance of 300 miles.

There is everything at Portland to render the construction of a breakwater easy, cheap, and expeditious, and the holding-ground in the road is particularly good. A large part of the island facing the bay is Crown property, and contains abundance of stone. It has numerous springs, and plenty of the best water may be led in any direction for the supply of ships.

The roadstean also possesses the advantage of an inner harbour at Weymouth.

HARWICH HARBOUR.

Harwich Harbour.

We have now to submit to your Lordships a few observations respecting Harwich Harbour, which we consider one of very great importance to the trade of the country.

This harbour, formed by the junction of the rivers Stour and Orwell, is

one of the finest, and may be rendered one of the most useful havens in the kingdom. It has a sufficient depth of water and good holding-ground over an extent capable of containing many hundred ships.

But with the exception of a channel, of 18 feet in depth, too narrow for general purposes, the entrance to this port is not deep enough to admit ships of more than 12 feet draught of water at low-water spring tides; it is therefore at present a tidal harbour as regards ships of a larger class.

Convenient position.

It is remarkably well situated for the convenience of a North Sea squadron, and for the protection of the mouth of the Thames.

It is the only safe harbour along this coast, and is in the direct line of traffic between the Thames and the northern ports of the kingdom, as well as of the trade from the north of Europe.

There is a dock-yard with building slips belonging to the Crown, and the property under the Ordnance department is extensive.

Deterioration from neglect.

It appears in evidence that by the falling away of Beacon Cliff, on the west side of the entrance, and the lengthening out of Landguard Point on the east side, the harbour has sustained great damage within the last 25 years.

Cement stone.

The bottom at tbe entrance to the harbour, and the coast on each side, is composed of blue or London clay, in which are layers of "cement stone," in great demand both in England and on the Continent. Hundreds of hands are constantly engaged in collecting it, and the evidence shows that by excavating the cement stone in front of the Ordnance premises, near the foot of Beacon Cliff, the water has spread so as to be diverted from its natural course, and the tide rendered so comparatively feeble, that it no longer acts with its accustomed force on Landguard Point, which has consequently grown out 500 yards during the past 40 years, as shown by the plan. It has already nearly filled up the deep-water channel, and, by its further increase, threatens to destroy the entrance.

Admiralty Reports Appendix.

In the Appendix there are Reports to the Admiralty from the officer carrying on the surveying service in the neighbourhood of Harwich, to which we beg to refer for a full confirmation of our opinion of the necessity of taking immediate measures for the preservation and improvement of this harbour. If this be not done soon, it is impossible to calculate on the extent of mischief which may take place, for in every south-west gale the Beacon Cliff is in peril of being washed into the sea.

Breakwater recommended.

We therefore feel it to be our duty to submit to your Lordships the pressing necessity for carrying out a breakwater, or stone groyne, from the outside of the Beacon Cliff, so as to surround the foot of it, and to extend the same over the shoal-water, to the north part of the Cliff-foot rocks, as described in the plan (No. 6).

Dredging recommended.

We also recommend deepening the channel to the harbour to 18 feet at low-water spring tides by removing the shoals called the "Altars," and the eastern part of another shoal called the "Glutton."

PROPOSED BREAKWATERS.

Having made such observations respecting the different ports as may be necessary to enable your Lordships to form a judgment on the proposals we have to submit, and having given to the subject referred to us all the attention which its importance demands, we recommend:—

Dover Bay recommended.

FIRST, that a harbour be constructed in Dover Bay according to plan No. 1, with an area of 520 acres up to low-water mark, or 380 acres without the two fathom edge; with an entrance 700 feet wide on the south front, and another of 150 feet at the east end.

Entertaining the strong opinion we have expressed of the necessity of providing without delay a sheltered anchorage in Dover Bay, we venture to urge upon your Lordships' attention the advantage of immediately beginning the work by carrying out that portion which is to commence at Cheesman's Head.

Whatever may be finally decided upon as to the form and extent of the works in Dover Bay, the pier from Cheesman's Head, run out into seven fathoms water, appears to be indispensable as a commencement, and it will afford both facility and shelter to the works to be subsequently carried on for their completion.

This will give sheltered access to the present harbour during south-west

REPORT.

gales, and protect it from the entrance of shingle from the westward: it will afford time also for observation on the movement of the shingle within the bay, and for further inquiry as to the tendency which harbours of large area on this part of the coast may have to silt up.

These inquiries the Commission consider to be of essential importance, and the results will afford the means of determining on the greater or less width that should be given to the entrances of the proposed harbour.

Seaford Road recommended.

SECONDLY, we propose that a breakwater be constructed in Seaford Road in a depth of about seven fathoms water, one mile in extent, and sheltering an area of 300 acres, as shown in plan No. 2.

Portland Bay recommended.

THIRDLY, that a breakwater be constructed in Portland Bay, to extend a mile and a-quarter in a north-east direction, from near the northern point of the island, in about seven fathoms water, having an opening of 150 feet at a quarter of a mile from the shore, and sheltering an area of nearly 1200 acres, as shown in plan No. 3.

If only one work is to be undertaken at a time, we give the preference to Dover; next to Portland; and, thirdly, Seaford.

MODE OF CONSTRUCTION.

Mode of construction.

Various plans for constructing breakwaters have been laid before us by highly intelligent individuals, whose projects are noted in the Appendix, and fully explained in the evidence.

We are directed by your Lordships to report on the expense to be incurred by the completion of the works we may recommend; but as no approximate estimate of this can be made without determining the general principles and modes of construction, we have examined the engineers who have come before us, and other authorities, upon those important points.

Walls of masonry.

Their various opinions have been considered by the Commission, who prefer, for the construction of breakwaters, and for the security of the works of defence upon them, the erection of walls of masonry.

The Commission do not offer any opinion as to the profile or degree of slope necessary to ensure to the structure the requisite stability. They consider that this will be best decided by the Government, under professional advice, when the works shall be finally determined on.

Estimate of cost.

The cost of either mode of construction having been stated to be nearly the same, whether it be masonry, or a long slope of rough stone similar to that of Plymouth Breakwater, the Commission beg to lay before your Lordships an approximate estimate of the works at the several places, viz.:—

	£.
Dover	2,500,000
Seaford	1,250,000
Portland	500,000
Harwich	50,000

MILITARY DEFENCES.

The military members of the Commission are of opinion that there will be no difficulty in providing for the defence of the proposed harbours.

Military defences.

They recommend that casemated batteries be constructed on the breakwaters themselves, and that these should be supported by works and defences on the shore, flanking the approach to them and to the entrances of the harbours.

At Dover and Seaford there already exist works of defence contiguous to the site of the proposed breakwaters capable of being adapted to this object.

The island of Portland possesses great natural advantages for defence, and for the formation of a naval and military depôt during war to any extent that may be required.

The military officers are further of opinion that the position and construction of the works necessary for the defence of the proposed harbours cannot be decided on until the exact site and relation of the latter to the shore shall have been finally determined.

CONCLUSION.

Conclusion.

The Commission cannot close their Report without expressing, in the strongest terms, their unanimous opinion and entire conviction that measures are indispensably necessary to give to the south-eastern frontier of the kingdom means and facilities, which it does not now possess, for powerful naval protection.

Without any except tidal harbours along the whole coast between Portsmouth and the Thames, and none accessible to large steamers, there is now, when steam points to such great changes in maritime affairs, an imperative necessity for supplying, by artificial means, the want of harbours throughout the narrow part of the Channel.

Distance chart.

The distance chart which accompanies this Report shews the positions where, if our recommendations are carried out, harbours of refuge, or well-protected roadsteads, will afford shelter to our commerce. By these means, and with the advantages of steam by sea, and of railroads and telegraphic communication by land, the naval and military force of the country may be thrown in great strength upon any point of the coast in a few hours.

The several recommendations we have thought it our duty to lay before your Lordships must, if adopted, occasion a large outlay of the public money; but when life, property, and national security are the interests at stake, we do not believe that pecuniary considerations will be allowed to impede the accomplishment of objects of such vast importance.

T. BYAM MARTIN, Admiral, *Chairman.*
HOWARD DOUGLAS, Lieut.-General.
J. D. DUNDAS, Rear-Admiral.
J. H. PELLY.
PETER FISHER, Captain, R.N.
J. N. COLQUHOUN, Lieut.-Colonel, R.A.
R. C. ALDERSON, Lieut.-Colonel, R.E.
JOHN WASHINGTON, Captain, R.N.
J. WALKER.

I dissent from this Report, because I consider the mass of evidence to be in favour of Dungeness; and because I cannot recommend a large close harbour at Dover, where the pilots consider the holding-ground generally indifferent, and the engineers say it will silt up.

W. SYMONDS,
Surveyor of the Navy.

August 7, 1844.

MINUTES OF EVIDENCE.

LIST OF EVIDENCES EXAMINED.

LONDON.

		Page
May 1st	Captain Vetch, R.E.	1
	Rear-Admiral Sir James Gordon	1
	Captain Bullock, R.N.	4
May 2nd	Mr. Jeffreys	8
	Capt. Bullock, R.N.	9
May 7th	Capt. Hood, R.N.	9
May 8th	Mr. Steuart	14
	Mr. Pellatt	20
	Mr. Meckiff	23
	Mr. Bush	24
May 9th	Sir John Rennie	27
	Capt. Vetch	33
May 10th	Sir Henry De la Beche	39

RAMSGATE.

May 14th	Mr. Martin	41
	Mr. Aylesbury	46
	Mr. Werter Clark	48

DOVER.

May 16th	Mr. Stephen Norris	50
	Mr. Bailey	52
	Mr. Thornton	53
	Capt. Mercer	55
	Capt. Peat	55
	Lieut. Coombe	58
	Mr. Irons	59
	Mr. Basden	63
	Lieut. Smithet	63
	Capt. Hamilton	64
	Mr. Moull	64
	Mr. Worthington	65

EASTBOURNE.

May 17th	Mr. Calver, R.N.	66
	Mr. Clark	70
	Lieut. Conjuit, R.N.	70
	William Simpson	72
	William Head	72
	Lieut. Mann, R.N.	73
	Richard Harman	73
	William Breach	74

NEWHAVEN.

May 18th	Mr. Stevens	75
	Sir Henry Shiffner	78
	Mr. Cole	81
	Lieut. Fothergill, R.N.	85
	Lieut. Hemer, R.N.	86
	Lieut. Franklyn, R.N.	87

WEYMOUTH.

May 28th	Lieut. Marshall, R.N.	87
	Mr. Lowe	89
	Mr. Read	90
May 29th	Capt. White	92
	Mr. Allen	94
	Capt. Manning	96
	Mr. Harvey	97
	Mr. Jerrard	97
	Capt. Payne, R.N.	98

HARWICH.

June 6th	Mr. Saxby	98
	Capt. Bullock	102
	Capt. Deane	104
	Mr. Pattrick	108
	Mr. Calver, R.N.	110
	Col. Vavasour	113
	Mr. Cottingham	115
	Mr. Hales	117
	Mr. Cobbold	118

LONDON.

June 10th	Dr. Potts	119
	Capt. Crispin, R.N.	122
June 11th	Mr. Bremner	128
	Mr. Steward	136
	Mr. Barrett	140
	Sir Samuel Brown	145
June 12th	Mr. Smith	148
	Mr. Jeffries	151
	Sir Samuel Brown	152
	Mr. Mitchell	154
June 13th	Capt. Vetch	158
June 18th	Mr. Cubitt	165
June 19th	Mr. Hartley	176
	Mr. Rendel	180
June 20th	Mr. Stuart	189
	Mr. Rendel	193
	Capt. Richardson	194

DOVER BAY,

IN APRIL 1844.

Surveyed in H.M.S. Blazer.

The Soundings are in Feet, and are reduced to the level of Low Water, Ordinary Spring Tides; the Datum line is 2 feet below the Zero of the Harbour Tide Guage. The Tide rises 19 Feet on Springs, and 11 do on Neaps.

The portion of the Town tinted Yellow shews the proposed extension of Dover Harbour by the Trustees.

AREA OF PROPOSED HARBOUR.

To Low Water Mark	520 Acres.
To the 2 Fathoms Edge	380 Acres.
To the 3 Fathoms Edge	330 Acres.
Width of the Southern Entrance	700 Feet.
Width of the Eastern Entrance	450 Feet.

The t's indicate the Spots, where the Holding Ground was tested in H.M.S. Blazer.

Surveyed & drawn by Lieut Cudlip & Mr E. K. Calver, R.N.

Standidge & Co Litho London

DUNGENESS

EAST AND WEST BAYS.

May 1844.

Surveyed in H.M.S. "Blazer."

The Soundings are in Fathoms, and are reduced to the Level of Low Water at Ordinary Spring Tides.
The Tide rises 21 feet on Springs, and 11 feet on Neaps.

Scale of Miles.

1 0 1 2 3 4 5 6 7 8 9

Lydd Ch.

Section A.

The Vertical Scale, is to the Horizontal, as 3 to 1.

New Romney Ch.

Romney Bay
a place of shelter for Boats only

Dimchurch

C G^d Station

Battery N° 2

Battery N° 4

Battery N° 1.

Battery N° 3

Fort Dungeness Light

Stephensons Bank

WEST BAY

THE ROAD

EAST BAY

Swallow Bank

Roar (B) Spit or Newcome

Magnetic Compass

Engraved & Drawn by Lieut^t Cudlip, & M^r E.K. Calver, R.N.

Hydrographic Office Admiralty London

EAST-BOURN AND PEVENSEY BAYS

with the

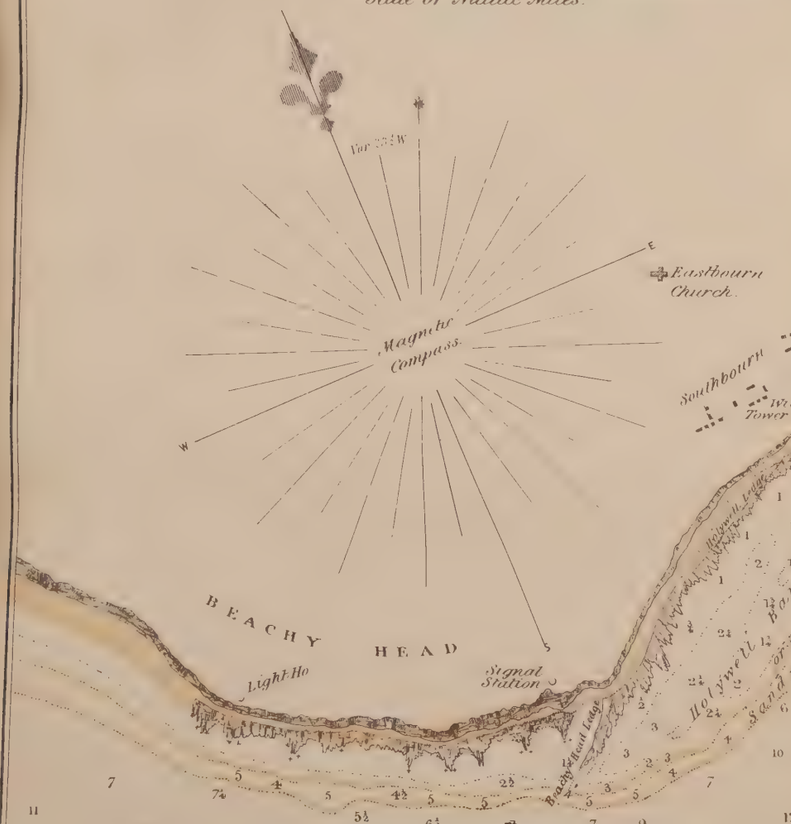
ROYAL SOVEREIGN SHOALS

Surveyed in H.M.S. V^e Blazer, in June 1844.

The Soundings are in Fathoms. — Spring Tides rise 20 Feet, Neaps 14.

1 ¾ ½ ¼ 0 1 2

Scale of Nautic Miles.



Surveyed & drawn by Lieu^t Cudlip & M^r E K Calver, R N.

Standidge & Co Lith^rs

Nº 4.

PROPOSED BREAKWATER.

Length ..... 2000 Yards.
Sheltered Area to the 3 Fathoms Edge, about ..... 250 Acres.
Idem ..... to the 2 Fathoms Edge ..... 350 Acres.

Blachington Ch.

Seaford Mill

Line of best Anchorage

Seaford Ch

Bridge

Newhaven Ch.

Cotts Tide Mill

For the Mill

Covered at High Water

Covered at High Water

Covered at High Water

Preventive Station

BATTERY

Preventive Staff

BARROW HEAD

Preventive Staff

BATTERY

BATTERY

SEAFORD HEAD

361 feet high

Stones

20 Fn. s.

35 s.

35 s & b

s & mud

Line of S.W. Exposure.

NEWHAVEN AND SEAFORD ROAD.

Surveyed in H.M.S.V. Fearless 1839.

The Soundings are in feet, at Low Water. Spring Tides rise 20 feet. Neaps 16 feet.

Scale, of One Nautic Mile.

Var 23½ W

Magnetic compass

Surveyed & drawn by Capt.ⁿ Bullock & Mr Burstal R.N.

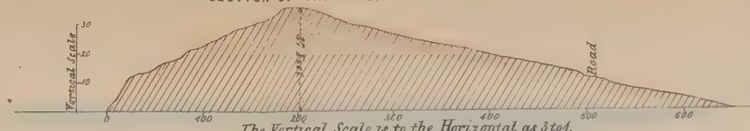
Steandidge & Cº 12 Strand London

PORTLAND AND WEYMOUTH ROADS.

PROPOSED BREAKWATER.

Length ..... 2500 Yards
Width of Opening ..... 50 Yards

SECTION OF THE CHESIL BANK IN THE LINE AB.



The Vertical Scale is to the Horizontal as 3 to 1.

Portland Race with Ebb in moderate weather

Portland Race with Flood in moderate weather

Bill

High Light

Low Light

Ledge

P O R T L A N D

Portland Church

Portland Castle

The Chesil Bank

Church Hope Cove

Castle (in ruins)

Stone Quarries

Folly Pier

Chain Pier

Nott Pier

9ft. of the Abergavenny

Shambles

WEYMOUTH

MELCOMBE REGIS

Wey River

PORTLAND ROAD

WEYMOUTH ROAD

Nixon

Light

Redcliff Point

Mill Cove

White nore Point.

Magnetic Compass

Var. 32° W.

Surveyed in H.M.S.V. 'Fearless.'
June 1844.

The Soundings are in Fathoms, and are reduced to the Level of Low Water, Ordinary Springs.

The Tides rise 7 feet on Springs and 4 feet on Neaps.

1 ¾ ½ ¼ 0 1 2

Scale of Miles.

Surveyed & Drawn by Comm.r Sheringham & Lieu.t Wood R.N.

B
Standidge & Co. sc. London

HARWICH HARBOUR,
IN 1844.

PART OF SUFFOLK

RIVER ORWELL

RIVER STOUR

PART OF ESSEX

Foxboro Hill

Walton Ferry

Walton Marshes

Walton Flat

Walton Creek

Bloody Point

Shotley Pt

Shotley Gate

Martello

Walton Martello

Black Granary

Bone

Gristle

Red

Naval Yard

Angel Gate Battery

HARWICH

Harwich Ocxel

Bath. Side Battery

High Light

Low Light

Redoubt

Slips, Docks &c.

Harwich Harbour

Parapet of Eastern Breakwater

Parapet of Western Breakwater

Beacon Cliff

Beacon Cliff Fort

Cliff Foot Rocks

Ch.d B. W.

Black Buoy

Red Buoy

GUARD

Glutton

Cod

Altar Flat

Altar

Landguard Point

Landguard Fort

Landguard Marshes

Landguard Beach

ANDREWS

ROLLING GROUND

PLATTERS

Black

White

Landguard Point to Felixstow. E.N.E. 3 miles
to centre of Bathside Bay. E by N ¼ N. 4 miles.

Magnetic Compass

The Soundings are expressed in feet. Spring Tides rise 12 Feet. Neaps 7.

Shews the limit of Beacon Cliff Blackmans Head and Landguard Point in 1804.

Limit of Beacon Cliff in 1752.

------ do. do. do. in 1709.

The Shoals tinted red are proposed to be dredged to a depth of 18 feet.

One Sea Mile

Surveyed & drawn by Mr E. K. Calver, R. N.

Section shewing the Destruction of Beacon Cliff between 1752, 1804 and 1844.

Section shewing the increase of Landguard Point between 1804 and 1844

CHART

Shewing the relative position of the

CHANNEL PORTS.

Drawn by M.T. Pourchier R.N.

Standidge & Co. Lithe London.

MINUTES OF EVIDENCE

TAKEN BEFORE

THE COMMISSIONERS UPON THE SUBJECT OF HARBOURS OF REFUGE.

Wednesday, 1st May, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Captain *James Vetch,* examined.

Capt. *James Vetch,* R.E.

1st May, 1844.

(*Chairman.*) Are you now in the Royal Engineers?—I am.

You have a proposal to make to the Commissioners on the subject of the Harbours of Refuge?—I have been long considering the subject of the harbours of safety, and I have now a Memoir on the subject, which I beg leave to lay before the Commissioners. (*The Witness delivered in the same*) This is a Memoir which I published previously, which is referred to in that one; the plans which belonged to the Memoir are not published, but here are the manuscript plans which I beg leave to hand in. (*The Witness delivered in three plans.*) This is a plan showing the boundary of the chalk line on the two coasts, and illustrating the geological formation. (*The Witness delivered in the same.*)

Have you anything more to add?—Nothing at present.

[*The Witness withdrew.*]

Rear Admiral *Sir James Gordon,* examined.

Rear-Admiral *Sir James Gordon.*

(*Chairman.*) Mr. Cubitt, in his Report to the late Chancellor of the Exchequer, speaks with great confidence as to the accuracy of his estimate for constructing the harbour at Dover, which he says will be under 1,500,000*l.* These are his words, "my estimates bear a very large additional allowance for contingencies, and I submit them with the fullest confidence that they will bear the strictest investigation." Your Report, page 12, says each of those harbours, Dover being one, may be taken to cost none of them less than 2,000,000*l.*, and not much exceeding that sum. How do you account for this great difference between that sum and Mr. Cubitt's estimate?—The estimate that I had anything to do with was given in 1840.

Mr. Walker, one of the Commissioners, explained that the other referred to a date of 1843, and was for a different plan.

(*Chairman.*) You appear to have visited all the ports and creeks on the south-east coast, from the mouth of the river to Selsey Bill; what place do you consider the best calculated for a harbour of refuge for the trade of the Channel, and atthe same time the best suited for squadrons of vessels of war to protect the navigation of the Channel?—In the Report, we recommended Dover in the first instance; but I do not know whether we laid any particular stress upon Dover. "The situation," we say, "which appears to us to be of the greatest importance, and at the same time to offer the most eligible position for a deep-water harbour, is Dover Bay." That is in page 11 of our Report,

Which do you consider the next most important position?—The next most important, I think, was Beachy Head.

Which side?—East of Beachy Head.

Did your colleagues entirely concur in the opinion which you have now expressed?—I should say, decidedly; we may have differed in some small details in making the Report; in the manner in which it was made out.

But as to the positions which you have described, you entirely agreed?—Yes.

In speaking of the proposed harbour at Dover, you say that your opinion is in favour of two entrances, one to the east and the other to the west?—Yes, as it is recommended in our Report, I should presume that I did at that time agree to it.

Have you read Captain Beaufort's and Colonel Thompson's observations on Mr. Cubitt's plan, in which they recommend only one entrance?—No, I have not; I never heard of it before that I recollect.

It seems to be the apprehension of those officers that two entrances would occasion the harbour to fill up with the drifting shingle; do you think that that would be the case, or that two entrances, which would give greater activity to the current, would rather tend to keep the harbour free from such accumulation?—I would rather not give an opinion upon that; I feel myself so perfectly ignorant about the drifting of the shingle, that I cannot speak upon it; it is an engineering question: perhaps it would be right for me to tell you that when I went upon this duty that was imposed upon me, we fixed upon the place which we thought the best for a breakwater, and then left it to those gentlemen who knew a great deal better than we did upon engineering points to decide. All that I heard of the shingle

Rear-Admiral *Sir James Gordon.*

1st May, 1844.

when I went down there was so very contradictory, and so very extraordinary, that it was quite impossible for me or anybody else to form an opinion upon it.

But, as a sailor, would you recommend one or two entrances to the harbour?—As a sailor, I should say that two entrances to the harbour would be much better than one; one to the eastward, and the other to the westward.

As two entrances, east and west, would naturally give greater velocity to the tide, do you think it would to a degree make it inconvenient for short-handed ships to bring up in blowing weather?—I do not apprehend that there will be the slightest danger.

If it should be determined to have two openings, do you see any objection to having the eastern entrance only 250 feet, being more than twice the breadth of the present harbour at Dover, bearing in mind that the eastern entrance will never have the same sea running upon it, and will never be so much in use as the other entrance?—I cannot give an opinion upon it.

Do you consider that a harbour of refuge with one entrance only would possess facility of ingress and egress at all times of the tide, and under all circumstances?—I should think that any harbour would be much better with two entrances, and we proposed to all those harbours two entrances, except to one under Foreness.

In the Dover projected harbour you have three entrances?—Yes; three entrances appear here.

(*Adm. Dundas.*) As a sailor, and knowing that the wind is for nine months in the year westerly, supposing there were two entrances to Dover Harbour, would not you think that the entrances which are to the south and east, would be the best approaches to the harbour of Dover, filling up the third altogether, which is to the west?—Yes; no doubt of it.

Is not the west entrance necessary for vessels to give them the full command of the anchorage in blowing weather, and also to enable vessels to get into the inner harbour?—Vessels can only get into Dover Harbour at certain times of the tide, and whenever they got inside the entrance of the proposed harbour, it would be so smooth that there could be no difficulty in their getting into the inner harbour when there was water enough for them.

(*Chairman.*) In your Report, favourable mention is made of Foreness as a desirable port for a harbour, did you think it preferable to any part within the Downs?—We did.

You appear to have objected to the enclosing of the Little Downs by a work on the Brake Sand, "on account of the magnitude of the work, the small depth of the water at the northern entrance, and the uncertain nature of the foundation," was this the unanimous opinion of you and your colleague?—I presume it was, but I cannot vouch for it at all: I certainly, myself, was very decidedly of opinion that it would not do.

You had a very intelligent colleague, an Elder Brother of the Trinity House, the late Captain Drew, who was intimately acquainted with the Downs, and was qualified to form a sound judgment, did he completely concur in thinking such a plan unadvisable?—I should think he did, because I had so high an opinion of Captain Drew's ability, and I knew him so intimately, that I think if he had proposed such a thing, he must have persuaded, not only me, but all the others, that it was the best place; but I should say, most decidedly, that he concurred with us.

This proposed harbour, the Brake, though I believe it is not called a harbour, appears, according to Sir John Rennie's plan now on the table, to be open to the south-west, and as much exposed to the sea and wind from that quarter as any part of the Downs; did you consider that an objection to it at the time?—It appears in the Report that we have made here, that the breakwater was proposed to be run off from the shore. I have no recollection of that: it must have been proposed or it would not have been entered in the Report; but I have no recollection of it. But my objection to a harbour inside the Brake is this: if there had been any shelter inside of the Brake, I think our ships during the war would have taken up their anchorage there; but I do not remember that they ever did. As the wind blows directly through between the Brake and the shore, as it does between the Brake and the Goodwin, vessels were obliged to anchor well to the westward, so that if they parted and cast to port they might run through the Gull Stream, and to make it a harbour we must have run a horn from the end of the Brake, inland between Sandown Castle and Deal, (I am now speaking from recollection, of many years ago, and without having anything now to refer to,) which would have narrowed the entrance very much indeed.

You are aware that the north approach to this anchorage is so shallow as to have only twelve feet of water?—Referring to the chart, it does appear to be so.

Did you sound it?—I believe we did; but I am not sure.

Suppose the breakwater to be made there, if a ship of this draft of water, that is, twelve feet, were to break adrift in this anchorage in a south-west gale, what would be her probable fate?—We were recommended that vessels should run ashore there; they say it is the finest place in the world for ships to run ashore on that beach. We were informed that it much safer to take the ground upon Pegwell Bay than to run the risk of getting into Ramsgate Harbour.

A ship breaking adrift in the Downs on a flowing tide would have Ramsgate open to her?—Yes; if she did not draw too much water, she could go in no doubt of it.

You have been asked whether Captain Drew thought it unadvisable to make a harbour within the Brake, and what were the grounds of that unadvisability? was it simply, as you have stated, "that the magnitude and extent of such a work, which would require a breakwater and a pier of upwards of five miles in length, and the small depth of water at the northern entrance, and the uncertain nature of the foundation," induced you to abandon the

idea? were those the only grounds for which you abandoned it?—The only grounds for abandoning were, I think, those which are stated in the Report.

Are you aware of the nature of the anchorage inside the Brake at present?—No; I am not.

(*Capt. Fisher.*) Are you aware that, although men-of-war have not been in the habit of using the Small Downs as an anchorage, yet that, during the whole course of the late war, for many years it was the constant and usual anchorage of the merchant ships?—During the whole of my services I have never anchored in the Downs in a man-of-war but twice, so that I do not know whether ships were anchored in the Small Downs, or inside the Brake. did not know it was the Small Downs till now.

Are you aware that, although the Small Downs in its present state cannot be considered a harbour of refuge, yet that it is a most excellent anchorage, very much protected from every wind, except the S.S.W., that from the S.S.W. to the south-east and others, it is in its present state a comparative place of safety?—It is a comparative place of safety, certainly, but at high water it must be as bad as any part of the Downs, I think.

Do you think, in case of war, merchant-vessels would lie in the Small Downs, and be protected from the enemy's steam-boats?—If the men-of-war were anchored outside of them, and merchant ships were in the Small Downs, I think they would be protected.

The anchorage within the Brake shows soundings of 20 and 21 feet; do you think that, in a situation exposed to the S.S.W., a safe place for merchant ships of 800 tons, for instance, in a heavy gale of wind?—Not where there is such a heavy sea as there is at Deal; and I do not think a ship would anchor there if she could help it, nor could I learn that any ship had ever anchored there: nobody ever came and told us that they had anchored there.

(*Adm. Dundas.*) You proposed a harbour at Beachy Head; did you make choice of the particular spot, in consequence of the recommendation of Sir Edward Owen, who so long commanded the squadron at that station during the war?—No; we did not.

Do you happen to know whether Sir Edward Owen has expressed an opinion as to any position?—I think he has.

What is the name of that position?—Cuxmere Haven. He recommended that part to the consideration of the Commission; but it came rather late, and we had not an opportunity of giving it that consideration which we wished to have given it,

Suppose each side of Beachy Head to offer equal natural advantages for a harbour, which side, as a seaman, would you prefer?—The eastern side, certainly; the other cannot produce such advantages.

Does not the Royal Sovereign Shoal, and another near it, make the place you have pointed out at Beachy Head objectionable?—No; I do not think it does.

(*Chairman.*) When you were in the neighbourhood of Beachy Head, did you examine Seaford, with a view to a harbour there?—Yes; we examined Newhaven.

You have in your Report spoken of Dungeness as a desirable position for a harbour, but stated that it was impracticable to make one there?—We considered it so.

Did you land at Dungeness, and look at that part of the bay which Sir Edward Owen talks of cutting an entrance into from the westward?—We did not land at Dungeness; but we went to the top of the lighthouse, where we could see all over the place, without being at the trouble of landing at a spot where we could see only the length of the boat; and we saw where the proposed harbour of Mr. Douglas and Mr. Potter was to be, but we considered it perfectly impracticable.

Had you the Reports of Mr. Douglas and Mr. Potter before you?—Yes.

Where are they now?—I do not know.

You said that you considered that in the Harbour of Refuge at Dover the westernmost entrance might be dispensed with; to ships seeking refuge from the westward, in case of gales of wind, would not the westernmost entrance be necessary, not only as affording them greater facility of getting in, but to enable them to get in at all, inasmuch as the tide would run directly across the mouth of the southern entrance, in the same way as it does at Ramsgate?—As both these are upon a line, the tide would equally run across both; there would be no difficulty whatever, I should say, in getting in at the middle entrance.

Did you ascertain in the proposed position at Beachy Head whether the shingle there is found as inconvenient as in other parts of the coast?—From it being made only a breakwater, we did not conceive that it could be affected by the shingle; it would be washed through it.

What materials are there near there to make a breakwater of?—So far as I can judge, none; but I am not an engineer: there is plenty of chalk there; but whether that will do to make a breakwater or not I cannot judge; I should say no, because it would all wash away; but faced with stone, I have no doubt it might do.

When you recommended a breakwater at Beachy Head, you had some idea that some substance might be got near at hand to make the breakwater of?—We knew there was none, because there was no stone on the coast of England fit to make it of.

Then it would cost more than 2,000,000*l.* to make it, would it not?—The engineer said not.

[*The Witness withdrew.*]

Captain *Frederick Bullock*, R.N.

1st May, 1844.

Captain *Frederick Bullock*, R.N., examined.

(*Chairman.*) What ship do you command at the present time?—I am now doing duty in a small vessel lent to me till another is built; the Myrtle is the name of the vessel.

How are you occupied?—In surveying from the Naze of Harwich to the South Foreland.

You have been employed in surveying different parts of the south-east coast?—Yes; I was employed in examining the different harbours on the former Commission.

If with your intimate knowledge of the south-east coast you were called upon to fix upon the most favourable position as a rendezvous for a squadron of ships of war with a view to the protection of our own shore, or offensive operations, and at the same time afford a convenient refuge for commercial vessels passing through the Channel, where would you construct a harbour calculated for those purposes?—With reference to all those points, I should say Dover; I reported favourably of Dover before.

Do you think Dover Bay favourable for the construction of a harbour?—I think so; I think it is very possible to construct a harbour there.

In answer to a question put to you, 4395, you state that you do not consider Mr. Cubitt's plan for a breakwater or screen, as you call it, in front of Dover Bay practicable; why do you consider it impracticable?—There was a great deal of desultory conversation when I was examined; and my recollection is, that I stated that I did not approve of caissons on account of wood not being durable, and that was, I think, my only objection, not the impracticability of the plan.

What do you say of his plan of a close harbour encircling Dover Bay; have you thought of that?—Yes; I do not give any opinion upon engineering. I will not speak to the practicability of it at all; but it strikes me that if it can be accomplished, and be permanent, it is the very thing that is required.

There is a question put to you, 4426, "Suppose a vessel leaving Portsmouth, bound to the eastward, is caught in a heavy gale from the southward, and cannot go to Dover, what would be the use of a harbour of refuge there?" Your answer is, "She must run to the Downs." Undoubtedly, missing Dover, there can be no alternative for her but to run to the Downs; but suppose a ship caught in a southerly gale, what could prevent her entering an artificial harbour in Dover?—There would be nothing to prevent her getting in if there were a good entrance.

Have you made, under the direction of the Admiralty, a complete survey of the Downs?—It is not completed yet.

But you have made a survey?—Yes, sufficient for the purposes of answering the questions of the Commissioners.

It appears by your survey that there has been a considerable change in the position of the Brake sand?—Yes; there has been a good deal of alteration; but the sands still preserve the same features.

Is there the same space for anchorage within the Brake as there was before the sand shifted, as described in your Report?—No; certainly not, because the sand has moved within or towards the main land.

Is the space more contracted?—Yes.

Is there, in point of fact, a sufficient depth of water within the Brake for ships of a large class?—Yes; to the southward and westward of the Brake sand.

Suppose a S.S.W. gale blowing into the Brake, is there a good anchorage then?—Yes; for large ships, in 30 and 35 feet, to the westward of the Brake buoy.

Have you ever seen Sir John Rennie's plan of the Brake?—No; I have not.

How much is the channel narrowed?—A third of a mile.

Having the channel so much narrowed, do you still consider it a place fit for spacious anchorage?—No; it could be made a safe anchorage for small vessels, but not a large harbour of refuge for line-of-battle ships.

If it was built round in the same way that Dover Harbour is proposed to be, is there not greater capacity there for making a larger harbour than there is at Dover?—I think not.

According to the plan proposed for Dover Harbour, what number of vessels do you think it would contain?—I have not calculated it, because it depends upon how far you carry out the screen.

You have stated, and you adhere to that report, that the northern entrance to the Brake has only 12 feet of water in many parts?—The Old Cudd Passage has not so much, it has about 9.

Supposing a ship lying within the Brake exposed to a S.S.W. wind and sea, to happen to break adrift, she cannot escape by the North passage?—That is the great objection to the harbour. She cannot escape but through the Old Cudd at high-water.

Which do you consider the preferable place from your knowledge of both for the expenditure of a large sum of money for an artificial harbour, the Brake or Dover?—I have given my opinion before in favour of Dover. At the time that I reported upon all the harbours round the coast I was in favour of Dover.

Is it your opinion that the position of Dover is the most favourable of any as a rendezvous for a steam squadron for the protection of trade?—For the protection of the narrow seas, certainly.

Captain *Frederick Bullock*, R.N.

1st May, 1844.

What water have you in the Cliff's End Channel, which is another channel through the Brake?—11 feet.

Sir John Rennie, in speaking of the increased rate of the current within the proposed harbour, that is the anchorage at the Brake, says, "it will probably deepen the anchorage two or three feet;" if it should have that effect, do you think that the sand thus carried away at the flood-tide would be likely to settle down at the entrance of Ramsgate Harbour?—If it is carried away, it will be carried through the Old Cudd Channel or over the Shallows, on the shore beyond the harbour's mouth.

Not to the front of Ramsgate Harbour?—I think not; because there is no appearance of sand at all, except at the back of the harbour of Ramsgate, it seems all to go to the northward of the harbour.

But supposing, as Sir John Rennie says, that the sand moved so as to deepen the water two or three feet, what would become of it?—It would pass to the northward and eastward.

When it meets with a counter tide, or the tide acting upon it ceases, it must deposit itself?—Yes.

Where is that likely to take place?—At the back of the harbour, that is where all the sand is now.

Then it will come upon Ramsgate Harbour?—Not upon the entrance of the harbour any more than it does now.

You suppose that it will come to the sands at the back?—Yes, the sand is there increasing.

Do you think that a harbour could be made there with any degree of propriety?—Yes, for small vessels, such as could avail themselves of Ramsgate Harbour in cases of necessity.

(*Sir H. Pelly.*) Do not you think that at the south end of the Brake a harbour could be made off Sandown Castle for vessels of a large class?—Yes; if you carried this breakwater further out into deeper water, towards Deal Sand, it could be made.

Quite as large or double the size of Dover Harbour, capable of holding all the men-of-war, and all the merchantmen that come into the Downs?—Yes.

(*Chairman.*) Suppose a harbour of that description to be constructed, what is to become of the immense masses of shingle that are known to be driving up along that north line of coast?—If the harbour was extended out and prolonged from the shore, the shingle would then be stopped for the time.

And when the shingle is filled up as in all other groins, it would travel round the other point and get into the harbour?—I think there is a great difference of opinion as to the travelling of the shingle on our coasts; but my opinion is, that if the west head of the harbour was to be built out in the acute angle which the shore makes with the prevailing wind, the shingle would accumulate. Shingle is only moved by the waves, and then only acquires a progressive motion. Tide has scarcely any influence over shingle, and if the west head was prolonged into deep water, as above stated, it would probably never pass round it, for the direct influence of the waves would be to accumulate it on the shore.

(*Capt. Washington.*) But experience tells us that the shingle does not go to the northward of the Sandown Flats?—Yes; there is a place where it ends, termed Shingle End.

(*Sir H. Pelly.*) Considering the constant west wind and the position of the ports on the opposite coast, which of those two proposed harbours, that at Dover or the Brake, should you say would be the best with a view to protect the commerce of the country and annoy the enemy?—Dover.

Do you consider Ramsgate a good refuge harbour, taken at the proper time of tide?—Very good for vessels of a certain tonnage.

What brings the heaviest sea into the Downs?—South-west gales.

When vessels break adrift in the Downs, is it not in southerly gales with a heavy sea and a flood-tide running against them?—Yes, it must be the case with the two forces acting together.

Then when vessels break adrift in the Downs, the tide which breaks vessels adrift in the Downs is the flood-tide, which gives them a depth of water to get into Ramsgate Harbour; the same tide which breaks them adrift enables them to get into Ramsgate Harbour?—The question requires two answers; the first is, that it is certainly the tide that will take them into Ramsgate Harbour, but it must be at such a time of the tide that they will have water to get in.

But it is on the flood-tide, and the very tide which breaks them adrift is the tide which gives them water into the harbour?—Yes, but as the tide runs in the direction of the *flood* until half *ebb*, there would not be water all that time.

Speaking of the Brake Sand, do you know anything of the nature of it, of its solidity and stability, for the construction of works upon it?—We did pierce it to about four or five feet, and found it all sand; we never got below that. To the southward of the Cudd Channel and the second shoal, it is all sand.

(*Capt. Washington.*) Do you mean the Quern?—The Quern is chalk rock.

The Cliff's End Channel is to the southward of the Quern?—Yes, that is where the sand begins; that is the valley of the chalk.

Do you think it possible to deepen the water in any degree at the entrance of Ramsgate Harbour by a dredging-vessel?—If the dredging-vessel could be adapted to cut away the chalk it could be done.

Captain *Frederick Bullock*, R.N.

1st May, 1844.

(*Col. Colquhoun.*) By small buckets being strongly armed with steel it might be done, might it not?—Yes, I think it could be accomplished.

(*Capt. Fisher.*) You were asked, whether if vessels break adrift in the Downs, they break adrift in the same tide that carries them into Ramsgate Harbour; how long does the tide-stream run to the southward after it is flowing by the shore?—Nearly three hours.

If the wind is to southward, would not a vessel be riding on the ebb-stream till half-flood by the shore?—Yes.

And therefore low water by the stream is just the time for her to get under way to go into Ramsgate Harbour?—Yes, between that time and high-water, viz. three hours.

When the stream ceases they get under way, because it is flowing half-tide into Ramsgate Harbour?—Yes.

Consequently the tide can have no effect upon running her adrift?—No; not at that moment. The question as I understand it is, whether there would be sufficient water to get into Ramsgate Harbour., *i. e.* if the vessel had broken adrift on the flood between the time of half-flood and high-water.

Ramsgate Harbour can never be a harbour of refuge for large vessels?—No; but there can be no doubt of its utility, and it would be very greatly improved by continuing the Brake.

(*Adm. Dundas.*) With your relative knowledge of the situation of Dover, and the anchorage in the Small Downs, are you of opinion that under any circumstances a harbour of refuge could be made in the Small Downs preferable to that off Dover?—Certainly not; with respect to its position, if to a harbour of refuge you add a harbour of defence, I should prefer Dover under any circumstances.

You have heard of a harbour on the Goodwin Sands, do you think that feasible?—I think after you had made the harbour on the Goodwin Sands, you would then require to run out a very extensive breakwater to protect the harbour you had made, because the wind that opens upon the Downs opens upon the sands.

Do you find that the Brake sand has become narrowed, or has come bodily in towards the shore?—The latter; it otherwise maintains its general appearance.

The Gull Stream then has widened?—Yes, it is a better channel now; and I think the Trinity Board have found that by the removal of the buoys.

Have the Goodwins shifted?—Yes; they have moved a little to the south.

(*Chairman.*) Have you surveyed the coast to the north of the North Foreland?—Yes; the whole of it.

What is your opinion of Foreness as a place for the construction of a harbour; from your knowledge of that coast should you say that that position is favourable for the construction of a harbour?—Yes; I think it could be done.

Would the projection of a harbour into the sea from that point occasion any injurious change, do you think, in the direction of the tide?—It would interrupt the tide.

Would it throw it off in any direction to be injurious?—It would affect it a good deal, because the projection would be at right angles to the tide; there is no sand there, it is all chalk throughout; it is possible to build a harbour there.

(*Sir H. Pelly.*) You stated that, from the locality, Dover would be better than the Brake; would not the Downs be a great deal better than Foreness?—Certainly; there cannot be a doubt of that.

In speaking of the northern entrance to the proposed Brake harbour, is there any other channel than the Old Cudd Channel which is said to have 9 feet depth of water?—Yes, there is one called the Cliff's End Channel.

What depth of water is there in that channel?—Eleven feet.

Therefore it is a good channel?—Yes, compared to the Old Cudd.

Is the bottom sand or chalk?—Sand.

(*Capt. Washington.*) Would there be any difficulty in dredging a deep channel there, it being sand?—I think there is always a difficulty in removing sand.

But supposing a breakwater erected with piers, would not that channel scour itself out into a deep channel, with very slight assistance from art?—There is a great probability of it being benefited by the construction of a breakwater.

The Cliff's End Channel is immediately to the north of the extreme end of the Brake?—Yes; just to the north; but there is a disadvantage as regards the Cliff's End, that it is more at right angles with the direction of the tide than the Old Cudd.

You spoke of the shingle travelling along the coast; does it extend as far as Ramsgate Harbour?—There is no appearance of shingle at Ramsgate Harbour.

Do you know where it ends?—Yes, between Sandown Castle and the entrance to Sandwich Harbour, towards Shellness.

Where do you think the shingle goes to?—I cannot say; I followed it to the very last point of the shingle.

Have you ever noticed how far the shingle extends out from low-water mark, generally speaking?—No, I do not think I have noticed that; but at a very short distance we have sand and then mud.

Have you ever seen the shingle extend so far as low-water mark?—No, there is a line of sand always at low-water mark.

Can you assign any cause for the extraordinary change in the position of the Brake sand?—I cannot.

Do you think that it is possible that it might have been an error of the engraver in reducing Græme Spence's chart?—I think not: it was done very carefully; nor do I apprehend it was an error in Græme Spence.

Captain *Frederick Bullock*, R.N.

1st May, 1844.

Have you ever seen the original of Græme Spence's chart?—I have not;—that is the engraved copy.

Does the original exist?—I think not.

When you spoke of ebb and flood-tide in the Downs, did you mean, when you said the flood-tide, the south-west stream or the north-east?—There is one portion of that south-west, and the other north-east.

But when you speak of the stream going to the south-west, do you mean that to be the flood or the ebb?—I think, generally speaking, it is the ebb that is said to run to the south-west, and the flood to the north-east.

(*Chairman.*) Is it the general opinion of well-informed pilots and seafaring people on the coast that the Brake Sand has shifted?—They had no idea of it; nor, till I examined it, was there any idea of it. It had never been observed; the alteration has been so gradual.

Has the buoy been shifted from the south end of the Brake in consequence?—I think the middle Brake buoy has been shifted, not the south Brake buoy.

How long is it since it has been found that the sand has been shifting?—In 1840 it was discovered; I examined it in 1840.

Have you had any examination since 1840?—No.

(*Capt. Washington.*) Was there any examination between 1795 and 1840?—No.

Did Mr. Thomas survey the Brake?—I think he did not; he did not make a regular survey of it.

(*Adm. Dundas.*) Have you surveyed the coast round Beachy Head with reference to a harbour of refuge?—Yes.

If it were determined to construct a harbour at Dover to enclose Dover Bay, would you recommend an entrance at each end; or how many entrances would you recommend?—Two would be quite sufficient.

You approve of that plan that lies before you?—Yes; I think I should prefer having the entrance a little wider than 700 feet.

From the way the shingle travels at Dover, would you fear that the western entrance (A) would be filled up?—Not if this angle was made more acute to the coast; but as it is now, I think it would; the influence of the tide would take the shingle down to the point, and then it would wash round. I do not at all think that it would fill up, but it would wash round the point.

Supposing a ship came from sea with a strong gale from the westward, do not you think she might get into the harbour by the entrance (A a), which is the middle entrance?—Yes; but (A) is of advantage to get out.

Do you consider that, the western entrance shut up, the harbour would be as available for a ship coming in with a heavy gale of wind from the westward as if that entrance were open?—No; I should prefer the entrance open.

If the harbour is carried out into 6 fathoms at low-water spring-tides, should you have any apprehension of its being inconvenienced by shingle at that depth?—No, I should not.

(*Chairman.*) Have you surveyed the coast round Beachy Head?—I have.

Is there any part which presents a strong natural advantage for the construction of a harbour?—I think not, because to the eastward of that Head, where it appears so good, there is a sand which renders it impossible to succeed.

Do you think the position pointed out by the late Commission for a breakwater at Beachy Head objectionable from its being in the neighbourhood of the Royal Sovereign shoal, and of another shoal?—My report on this head was, that the sand was the objection.

You say, in answer to question 4493, before the Shipwreck Committee, "I thought very favourably of Beachy Head till I found the sand-bank under it;" will you be good enough to explain what you mean by the sand-bank under it?—We found a shoal of sand-bank to the eastward of the Head.

You mean that you found the sand ranging along under it?—Yes.

How far off did this sand extend?—About half a mile.

So as to inconvenience the anchorage?—Yes, it inconveniences the anchorage certainly.

What is the depth of water beyond the half-mile of sand?—Eight or nine fathoms.

Then you think unfavourably of that particular part; is there any other part of Beachy Head that you could fix upon?—No, not at Beachy Head.

Not on either side?—No; I think not.

Can you recommend any improvement that would make Newhaven capable of receiving large steam vessels?—No; it is a dry harbour.

Is it capable of being improved by any artificial contrivance?—I think not, on account of the shingle.

(*Capt. Washington.*) You have stated that Holywell Bank, which, according to your survey, lies half a mile to the eastward of Beachy Head, renders the bay to the eastward of Beachy Head unfit for a harbour of refuge?—Yes, where the shoal extends

Why should not the breakwater be carried to the eastward deeper in the bight of the bay, and thus convert Holywell Bank into a natural breakwater?—That might be done; the sand would itself then become a breakwater.

Is there within this breakwater any creek or opening?—No; it is a plain coast.

Is the holding ground within that proposed breakwater good?—Yes.

(*Chairman.*) Have you any other objection to Beachy Head as an anchorage but that bank under Beachy Head?—None.

Captain *Frederick Bullock* R.N.

1st May, 1844.

What would be the distance between the sand and low-water mark?—It is very little; it is close in.

Was any ship ever lost or struck there?—Not that I am aware of.

(*Sir W. Symonds.*) Do you think a harbour of refuge could be made at Dungeness?—I have hardly examined it sufficiently to answer that question; the great objection would be its shallowness, under the lee of the shingle of which the point is composed.

Do you think it is possible to cut through the shingle a passage such as Sir Edward Owen describes?—It would be possible to cut it through, but I do not think it would be possible to keep it clear of the shingle afterwards.

Looking at the two situations, Dover and Dungeness, supposing only one harbour of refuge was to be made, to which situation would you give the preference?—Dover, on account of its fortification, as combining two great purposes—refuge and defence.

Is there not hard chalk at Beachy Head?—Yes.

(*Chairman.*) Will you be so good as to look at the plan of 1840, and see the position in which the Commission have proposed a harbour at Beachy Head to be constructed. Referring to that plan, do you consider the Holywell sand to be an objection?—Certainly not, in that case.

Then what is the sand which you consider to be an objection?—The plan was making it close to the point, not removing the breakwater further to the eastward. I examined whether I could make a harbour at Beachy Head, and I imagined that it was proposed that it should be close to Beachy Head, and that in that case the Holywell Bank would be an objection, not otherwise.

Is there not plenty of material close at hand for erecting a breakwater at Beachy Head?—Certainly.

(*Sir W. Symonds.*) Do you know Swallow Bank in Dungeness East Bay?—Yes.

Is there good anchorage between that and the shore?—Yes.

Considerable space?—Yes.

Might not advantage be taken of Swallow Bank itself to make a breakwater of not more than two miles altogether, which would enclose a considerable space?—I am not acquainted with the character of the Swallow Bank, but I am of opinion that it might be made available.

Which side is it?—To the eastward.

Do you know any good anchorage without artificial means in a westerly wind besides Dungeness between the Owers and the South Foreland?—I know of none.

You admit that Dungeness is good anchorage?—Yes.

From the west, how far to the southward of the west?—That will depend upon the size of the ship, three fathoms or five fathoms would make a great alteration in the bearing.

Do not vessels occasionally take shelter under Dungeness, when they are going down Channel with west and south-west winds?—Invariably; I have myself taken shelter there.

(*Chairman.*) Do you know anything of the Owers, whether the anchorage by the Owers is capable of being converted into a good anchorage?—I have never examined the place, but I have heard that it is very good anchorage; it is hearsay evidence, but a very old friend of mine saved a ship there; it is a very good entrance, and very smooth water within the Owers.

Have you surveyed any part of the coast to the west of the Isle of Wight?—No.

[*The Witness withdrew.*]

Adjourned till to-morrow at 11 o'clock.

Thursday, May 2nd, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *Jeffreys,* C.E.

2nd May, 1844.

Mr. *Jeffreys,* C.E., examined.

(*Chairman.*) What have you to propose to the Commission?—A proposition for the improvement of Dover Harbour. The shingle which forms a bar at the mouth of Dover Harbour rests on a bed of chalk to the south-east of the harbour. I propose that a channel be cut through the bed of chalk in an easterly direction, so as to give a free passage to the shingle into the bay. The water from the culverts, if properly diverted, and let off just after flood-tide makes, would clear away the accumulation of shingle; the bed of chalk is about 3 feet above low-water mark at spring-tides. The water from the culverts is at present let off, just before low water, and carries the shingle from the apron directly upon this bank; the remainder of the ebb then carries the shingle to the west to be re-accumulated. If a channel were cut as proposed above, the shingle would be carried out, the harbour's mouth cleaned, and a double entrance given for shipping. Also to shorten Cheeseman's Head, and allow the sea to sweep the shingle along the beach past the mouth of the harbour (through the channel proposed to be cut) into the bay.

How long is it since you inspected the chalk bank referred to?—In August, 1843.

When did you see the chalk bank free of shingle?—Never but once; it was on the day of the Harbour Session at Dover; I think in 1837.

What width do you propose to make the cut?—100 yards.

To what depth do you propose to excavate the chalk bank?—Five feet below low-water spring-tides, with a slope of one foot in two at the sides; the bottom being level.

Have you ever, under any circumstances, known the harbour to have two entrances?—I have, for small vessels under 100 tons; one mouth to the harbour with an entrance

from the east between the bed of chalk and the north pier head, as well as an entrance from the south at two-thirds flood. Mr. *Jeffreys*, C.E.

2nd May, 1844.

What is your opinion as to a breakwater being run out from Cheeseman's Head? and the effect upon the shingle if an opening was made therein?—The shingle would accumulate on the west side of the Harbour wall, and travel along until it reached the mouth of the harbour, when it would be thrown into it, where it would lie at rest, and in time tend to fill the mouth. I instanced the accumulation of shingle at Dungeness, as I have stated in my communication of the 6th and 20th instant. My evidence relates to the improving the access to the present harbour; but my proposition for a harbour of refuge in the Bay has not been submitted to the Commissioners, and I beg respectfully to be allowed to do so.

The foregoing answers were illustrated by a plan of Dover.

[*The Witness withdrew.*]

Captain *Frederick Bullock.*, R.N., re-examined.

Captain *Frederick Bullock*, R.N.

(*Chairman.*) It is said, in question 1769, page 111, in the evidence before the Select Committee to Report on Shipwrecks, "Captain Bullock, after making a complete examination of Newhaven, was of opinion that that was the most eligible as a harbour of refuge westward of Beachy Head?"—I consider it, of the two, viz., Newhaven and Shoreham, as the best.

It is stated by Captain Hood, R.N., that you have bored in front of Newhaven?—This is a mistake, I never have; but I should say that the substratum was chalk rock.

Taking into consideration the object we have in view, the protection of the trade and harbours for cruisers, which do you consider the most proper for the purpose, that opposite Newhaven or that opposite Eastbourne?—Eastbourne.

What materials are there on the spot for making breakwaters?—An abundance of chalk and shingle.

Will the Sovereign Shoal be a difficulty with reference to any harbour opposite Eastbourne?—Yes; but the difficulty may be lessened by properly buoying and lighting that and other shoals. I consider that such precautions will remove any objection to the situation on that point.

Will you state your reason for preferring Eastbourne to Newhaven?—It is more sheltered from the westward, by Beachy Head, and secondly it is nearer the narrow part of the Channel, so that protection can be more readily afforded against an enemy's cruisers.

Do you consider such a harbour would be as easy of access as Newhaven for ships requiring shelter?—I consider it would, be not only equally easy, but, if blowing strong from the westward, the facility of getting it would be far greater.

In giving preference to the harbour eastward of Beachy Head, could vessels haul out again as easily, without being embarrassed by a lee shore?—Certainly; I consider this another reason for its preference.

Do you know who first proposed a harbour of refuge at Eastbourne?—No; I do not.

[*The Witness withdrew.*]

Tuesday, 7th May, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Captain *William Hood,* R.N., examined.

Captain *W. Hood*, R.N.

7th May, 1844.

(*Chairman.*) You have delivered to the Commissioners various papers respecting Newhaven. You say your opinion is founded on observations made on the spot while you were officially employed there?—Yes.

Your object seems to be to obtain a powerful sluicing operation by converting Sleepers' Hole into a reservoir for back-water?—Yes.

By these means you propose to push the shingle and sand away from the mouth of the harbour?—Yes.

What do you suppose will become of it?—It will be taken by the tide up Channel, as the whole of the shingle is known to drift to the eastward along that coast.

How far from the pier does this ebb-tide or outset extend, do you suppose, and into what depth of water?—I should say its influence outside extends 800 feet.

Into what depth of water will that carry you?—about six feet at low water.

When the ebb-tide and the power of the scouring water is spent, or is checked by the tide, will not the sand or mud immediately settle down and add to the shoal water already existing at that distance in front of the harbour?—No; I propose digging into the primitive clay so that that will form a channel itself below the piers. I have a boring apparatus for that purpose.

When the ebb-tide passes the east pier, does not the water expand into the bay?—At present a good deal.

Between Newhaven and Seaford, does it not?—It does.

There is a tendency to shoal water by the deposit of the harbour mud?—There is;

Captain *W. Hood*, R.N.
7th May, 1844.

the mud out of the harbour has very slight effect. There are groins also all along the beach, between that and Seaford for the stoppage of the shingle; this will be shown on the model.

Then if the east pier is extended, will not that prevent the spreading of the water and the shoaling in the bottom of the bay?—My proposal is to widen and extend both piers so that there may be the length of a sea without its breaking against either pier head.

To what distance do you propose to lengthen the piers?—About 500 feet beyond the present piers.

Are you aware that this lengthening of the piers has already been proposed by engineers who have been down there?—I am aware of that; but my present plan is founded on the knowledge acquired, having been for many years the executive officer in a frigate at Newhaven, when my attention was called to the properties of the port by the late Lord Chichester through Mr. Thomas, his relative.

These are your drawings? (*Two drawings being shown to the witness.*)—Yes.

At what distance from the west piers seaward do you get five fathoms water?—I should say at 1500 feet or thereabouts. I cannot be more precise without referring to my report; I have frequently sounded off the harbour.

Are you aware that Mr. Whitby, who was employed to examine Newhaven in 1823, recommended that the part you intend for a reservoir should be converted into a wet-dock?—I was not aware of that; this is the first time I have heard of it.

He says, "I would recommend that a dock should be made a little within the entrance of the harbour on the western side, at the place called Sleepers' Hole. If such a dock were made at Newhaven, I am of opinion that the trade of the country would be greatly benefited thereby"?—I am aware that that was the original channel of the river, and that a sloop-of-war lay there about sixty years ago.

Are you aware that Mr. Jessop has since that proposed Sleepers' Hole for a dock? I am not.

You also propose to obtain the sluicing power by water penned up on the opposite side to Sleepers' Hole, near the entrance of the harbour?—Yes.

You recommend groynes on each side of the harbour to give a wider first entrance as you call it?—Yes.

To what extent are those groynes to go?—500 feet.

What distance are the piers to be apart from each other in widening the mouth of the harbour?—About 400 feet.

With a flood-tide running in and a fresh gale, would not the piers and the space between them and the proposed groynes occasion a violent rebound of the sea, and render the inner entrance dangerous?—I should say not; I think that would act like a bell mouth; my observations while I was on the spot went to the extent, that if anything of the kind was adopted you would get smooth water.

The question supposes the wind to be blowing right in, the sea and the wind going in?—I do not think that would make any difference; but that it would be a great advantage that the sea should be broken.

Is it to be understood that the pontoon you propose should fill up the passage of the harbour, the water of the harbour being made to act as a sluice, instead of running out in the ordinary course?—Occasionally when the weather will suit, I should wish to place the pontoon in any convenient part of the harbour within the pier heads. I take a pontoon of 106 feet long, that is about the length of an ordinary sized gun-brig.

That is the breadth of the harbour?—Yes; all the way up and down the harbour, there are piles for vessels to lie at, there are many places where they might be made wider than the entrance of the harbour; occasionally they might be made solid, which are boarded up; then the pontoon placed between such piles and the opposite side would act in displacing the water, as I can show upon the model.

You say in your paper that the pontoon is to be laid across the harbour after the trade has come in on the flood-tide?—Yes.

What are the vessels to do when they wish to pass out on the ebb-tide?—It has not been usual for them to pass out on the ebb-tide. I do not know that I have ever seen a vessel go out after the last quarter-flood. I have been in the habit of sending our tenders in and out, but have never attempted it except in the flood-tide.

At what time do they come in?—They come in during the last quarter-flood, there is 13 feet on the bar at half-flood.

You say it is within your power to deepen the entrance of the harbour, and that Captain Bullock bored 17 feet at the harbour's mouth into blue clay?—Yes; precisely.

(*Lt.-Col. Alderson.*) And that you can accomplish it by means of an auger?—Yes; I have a model here.

Will you explain the mode of using this auger, and the quantity of mud or sand it would bring up at one bore?—I at first thought that six feet would be the best diameter for the auger, but I think that four feet would, upon the whole, be best. Eight men with a capstain-purchase with a screw could bore to any extent even to the 17 feet if necessary. With the returning power of the screw the whole of the soil would be brought up into a guard, the centre of the auger being on a pivot and the soil being deposited alternately on each side of the barge. Of course the greater the depth required the less the diameter of the auger would be that would be used. I have two kinds of augers, one for boring into hard soil and the other into clay, either instrument being more suitable than the common dredge for going down into the original clay or hard bottom.

Captain *W. Hood*, R.N.
7th May, 1844.

How long will it take to bore 10 feet?—I should say a quarter of an hour; I propose allowing the lighter to ground, if possible, in that case she would always clear her length every tide. I propose that every tide, night and day, she should clear her length.

(*Mr. Walker.*) What quantity would you bring up at one time with your auger?—I should say a ton each time at least.

Have you ever entered into any calculation of the expense of building a vessel and providing the necessary machinery for this purpose?—No; I have not gone to that extent. I did not think the matter had advanced sufficiently to go into that; I should think it would not be expensive.

How many men would you require to perform the work in the harbour?—Eight men; that is the whole number I should recommend. If a steam apparatus should be applied, of course it would go on much quicker, and that would be more advisable in consequence of the power of availing ourselves of fine weather, to work outside.

As you recommended deepening to the extent of six feet, but now only four, have you ever calculated how long it would take to deepen a space of any given extent, say fifty yards between your proposed groins?—I have not, for that would depend altogether upon the state of the weather. If it blew hard and fresh, they could not work outside; but I propose in blowing weather to work inside, and in fine weather and outside.

(*Lt.-Col. Colquhoun.*) Have you ever made a calculation of the whole expense of raising and relanding the soil?—No; I have not had time to make that calculation.

As the operation of boring would necessarily be a slow process, would there not be danger of one hole filling up again before another was finished?—No; I think that the primitive soil being bored, the discharge of water from the harbour would prevent any accumulation taking place.

The water can be deepened throughout the whole fair-way, and the approach to the harbour would be improved by deepening the immediate mouth of the harbour?—I should propose to begin at the outside, and I should deepen the fair-way also.

(*Sir Howard Douglas.*) You think you could make improved approach esat an earlier period of the flood-tide by this process?—Certainly; I should think at least two hours.

Would your proposed operations be confined to the outside of this caisson or floating-gate you propose?—The floating-gate is to be confined within the entrance.

What do you propose to do with the floating-gate afterwards?—I can shift the floating-gate to any part; I can shift it to the upper part, if required, where there are piles fitted.

How far up do you propose extending your deepening?—As far as is necessary for shelter or for commerce; indeed the commerce can be only for the supply of the neighbourhood, which is in fact Lewes; but as the necessity was felt, we should use the boring or the sluices higher up.

Your sluicing would all be between the pontoon and the sea, or would you fix it higher up?—As I proceeded, I would carry it up.

Then you must carry up the pier-heads?—No; that would not be necessary. Between the river wall and the piles on the opposite side on which the shipping lie, a pile might be planked round, in lieu of remaining open, then the pontoon should be placed between the piles and the river wall.

Narrowed?—Yes; and that it should be discharged at any one place that practice showed to be best suited.

You would have occasional narrowing in width in certain places?—Yes; there are those places now.

Do you expect that the sluicing, caused by the operation of the pontoon, should deepen the wide places that will exist between the contracted places?—Yes; where that could not be accomplished, the boring-machine would accomplish it: those piles are already there.

(*Admiral Dundas.*) Do you consider that by all the improvements you suggest, Newhaven could be made a harbour easy of access at all times of the tide to vessels requiring shelter from stress of weather?—I think it could be made a harbour easy of access between the outer piers.

Could it be made easy of access at all times of the tide to vessels requiring shelter from stress of weather?—Yes; I think so.

Vessels of what depth?—I should say that, by boring and by sluicing into the primitive soil, the blue clay, the only obstacle would be the shingle on the mud, which would be displaced by the sluices.

Do you mean at all times of the tide?—Yes; I should decidedly say so, by extending the piers,—of course they must be extended.

You think that after that the harbour would be accessible at all times of the tide?—Yes; I think it would be capable of access, decidedly.

At what draught of water?—For the large class of steamers, 15 feet at low water.

How far would you carry out your pier?—I would carry out the pier 1000 feet, allowing one portion of it to go 200 feet within the other.

What soundings are there 1000 feet from the shore?—I think there is about five fathom.

What bottom is there?—The blue clay; of course it would require heavy piles for the piers.

How does the harbour mouth run?—I think it runs about N.N.W.

Do you mean that steamers of large size would be able to take shelter under this sort of projection, or that they might actually enter the harbour?—Enter the harbour if the harbour is capable of access, which it would be if it was made deeper, and the entrance improved.

Captain *W. Hood*, R.N.

7th May, 1844.

What is the occasion at present of vessels not being able to get in or out until the last quarter of the flood?—Because the piers are not extended enough, and the channel has not been deepened.

The piers will remain the same as they are, only that you will make another set of piers outside?—Yes; expanding.

Therefore the same inconvenience must remain as to the tide?—I think not; it is not the narrowness, it is the depth. If you increase the depth between the piers, the vessels will be able to get in as well between the narrow as the wide piers.

You say that no vessel can come out on the ebb-tide; what is the reason of that?—That is in consequence of the immense run of the tide over a shallow bottom.

And the narrowness of the channel, which makes the force the greater?—Yes.

Do you know at what rate it ebbs out of the harbour?—I think about five or six knots, depending on the quantity of water, and whether the low lands above are flooded from rains or not.

(*Captain Fisher.*) By the plan you propose, and the model which you have brought for the consideration of the Commissioners, which you state to be with a view of making Newhaven accessible at all times of the tide, what would be the least depth of water at the lowest spring-tides?—I should say 13 feet.

Does your plan for the improvement of Newhaven Harbour, which you bring forward for the consideration of the Commissioners, and the model, go to the extent of making it accessible to all ships at all times of the tide?—Yes; I do not mean line-of-battle ships or frigates, I mean powerful steamers and merchant-ships.

What depth of water should you be able to ensure such vessels if induced to enter at the lowest tides?—I should not say that a vessel drawing more than 13 feet will be able to enter at low water.

You mean that a vessel would be sure to find 13 feet at the lowest spring-tides?—Yes.

What is the width of the harbour mouth at present?—106 feet.

What should you propose to add?—I should add 250 feet to that, and I should carry the eastern pier further to the eastward.

The plan you bring forward, and which you propose illustrating by your model, you conceive goes to the extent of admitting all ships at all times of the tide?—Yes, it does.

Ships of moderate draught of water?—Ships drawing 13 feet.

You were understood in your first answer to state that vessels could not come in at all times of the tide, but that you should make it accessible two hours earlier?—I conceive it would be accessible at all times of the tide for vessels of that draught. I would beg to state that there is an immense back-water, which renders Newhaven capable of being made into anything that may be required.

(*Captain Washington.*) Supposing a vessel to run for Newhaven in a south-west gale, and owing to a sudden fog or any other cause she should miss it, could she haul off the shore?—I would answer that question by stating, "that I have known one of our tenders to make an offing when she had been embayed by a sudden gale; I will give the instance: the "Highflyer," commanded then by the present Commander Pearce, when a mate of the "Hyperion," came off the harbour deeply loaded with provisions, and the best part of it on deck. I sent out the boats to bring in the provisions; but the boats were lost: the vessel was saved by making an offing in a heavy gale of wind; it came on to blow tremendously heavy; the boats put ashore off Bear's Hyde; I got the provisions ashore there, but lost the boats: we had been obliged to wait for the tide to send out the boats; we could not send them out with the ebb-tide, and I waited till it was high water. While they were taking in the provisions, Mr. Pearce felt that it was necessary to make an offing; he cast off the boats, and made an offing by weathering Beachy Head.

(*Admiral Dundas.*) Here the gale came on while the vessel was unloading; but put the case, that a gale of wind had been blowing two days before?—During the five years and odd I was there I only knew of one vessel being wrecked behind the piers at Newhaven.

Have many vessels run for that?—A great many used to come in for shelter.

Did you never know of more than one vessel being lost between Newhaven and Beachy Head?—A great many have been lost between Newhaven and Beachy Head; but I am speaking of Newhaven itself.

The vessel you refer to had run for a port in a heavy gale?—Yes.

Suppose a vessel at sea, and she sees that dirty weather is coming on, and she wants shelter, would she rather have a breakwater harbour east or west of Beachy Head?—My preference is in favour of another harbour immediately to the westward of Beachy Head, which is Cuckmere; it might be that she could not get round the Head; there are many instances of vessels having been embayed there, and lost.

On which side of Beachy Head would a vessel, under such circumstances, prefer to have a breakwater?—I should say decidedly to the eastward; but I do not know how, in many instances, they could get at it.

If you were asked, as a sailor, to which side of Beachy Head you would run in a gale of wind, with the wind S.S.W., what should you say?—I should decidedly keep to windward, and go round the Head if I could.

(*Sir W. Symonds.*) With that sort of weather coming on, on which side of Beachy Head would you, as a sailor, wish for a breakwater to run for, one on the east or one on the west?—That requires very great consideration; it is not at all connected with that which I proposed; it might happen that vessels coming up Channel might get embayed in Seaford

Captain *W. Hood*, R.N.
7th May, 1844.

Bay, and might not be able to get round Beachy Head at all; my plans provide for shelter to the westward, not a breakwater.

Supposing you were bound down Channel with a fair wind, with an easterly gale, and ten leagues west of Beachy Head, the wind came round from the southward to the south-west, and blew hard, and night was coming on, where would you, under such circumstances, be glad to find a harbour of shelter constructed, to the east or the west of Beachy Head?—I really never gave a thought to a harbour to the east of Beachy Head, seeing the difficulties of constructing one.

Supposing a harbour of refuge to be provided, a breakwater harbour on one side or other of Beachy Head, which would you prefer?—For a breakwater harbour, I should say to the eastward of Beachy Head.

(*Chairman.*) You have a plan also for giving a more straight direction to the entrance of Cuckmere Haven?—Yes; and deepening it also within.

Is there any river or stream within Cuckmere that might be made available as a back-water?—There is a very powerful stream runs over the Haven at present; what I should propose is, to reserve the spring-tides at high water within a pontoon.

Has this proposal any connexion with your plan for improving Newhaven?—For the reasons I have given in the paper I have laid before the Commissioners, I conceive both Cuckmere and Newhaven would be very important, as ports of refuge, for vessels that could not round the Head.

Then you propose to improve these ports?—Yes, and that they would be essential for steamers-of-war, and for the protection of the Channel trade in case of a war, when cruizers would be obliged to bear up under strong S.W. gales.

What you propose for Cuckmere is the running out of two piers?—Yes, and the deepening within; it must be deepened within considerably.

In what direction would the piers point?—Nearly north and south.

It would be open to the south gales?—Yes, open to the south wind.

Fronting in that direction, would not the harbour be liable to the incursion of sand and shingle?—I think not; the pent-up water would prevent that after boring down into the original clay for a channel, the reserve of water when let loose from the pontoon would carry out the sand to seaward, and its ordinary drift to the eastward would carry it away from the harbour mouth towards Beachy Head.

Your suggestion does not go to any improvement at Seaford?—No, I have not taken that at all into my view.

You think that Cuckmere is a more eligible place to deal with?—I do.

Is there anything more you would wish to state to the Commissioners?—I am not aware of anything more than what is embodied in my papers.

You have stated only concisely what is embodied in your papers?—Yes, so far as I have been questioned; I should wish to explain my hydraulic models, which I have nearly ready in a room outside.

Your plan of improvement of Cuckmere goes to the extent of making it a harbour of refuge?—Yes, precisely so, accessible at all times.

To what extent of draught?—To the extent of 13 feet, for it is as capable of being made as good a port as Newhaven.

(*Sir Howard Douglas.*) How far does the depth of water outside Cuckmere afford facility of access?—The water is much deeper outside of Cuckmere than Newhaven; the sand does not extend more than 50 feet from the river mouth, I think.

You speak of there being a back-water, where is that?—There is a mill a great distance off, at the head of it.

Is it a stream capable of being turned to any account?—Yes, there is a great deal of water rolls over the shingle at times.

There is an embankment and a dam across it?—Yes; at the mill.

And a mill which uses the water above?—Yes.

You would not take any measures to deprive the mill-owner of the water?—No, I think there would be quite sufficient after boring into the primitive soil lower down.

What number of vessels do you suppose that Cuckmere would receive if your improvements were carried out?—I should say fifty.

Vessels of what size?—Fifty vessels of 500 tons.

The improvements you proposed are, constructing two piers and clearing out the harbour?—Yes, deepening the haven.

(*Mr. Walker.*) Have you ever tried boring?—Only in the model, but I am convinced of its feasibility.

To what distance do you propose to carry your piers at Cuckmere?—500 feet.

You have not entered into any estimate of the expense of carrying out the piers?—No, on the boring principle it would be less expensive than in any other mode of excavating.

What are the piers to consist of?—The same as Newhaven pier, or piles filled up with chalk. I should make them as solid as they could be made with wood.

(*Admiral Dundas.*) Supposing you were in a hard gale of wind blowing strong, and Newhaven were improved with an enlarged entrance, and there was also a breakwater to the east of Beachy Head, and you had it in your power to run either for Newhaven Harbour or the breakwater east of Beachy Head, which should you go for?—If I had it in my power to run for Beachy Head, and were going up Channel, decidedly I should run for Beachy Head if there was a breakwater there; but the accomplishment of the breakwater which has been long talked of, appears very doubtful in my opinion.

Captain *W. Hood*, R.N.

7th May, 1844.

Supposing you were in a gale of wind being bound down Channel, with a south-west wind, and that you had on the one hand Newhaven Harbour to run for, with a narrow entrance, and on the other a harbour under Beachy Head, which should you run for for safety?—My bias is in favour of Newhaven. I would run for Newhaven, for I would get as far to westward as I could.

Laying aside all bias, and speaking as a sailor, which should you go for?—Beachy Head breakwater when it is done; I should have this advantage, that I could get in and out at all times if they make it as it is proposed; but many vessels could not run there; there are instances of vessels being wrecked that could neither reach Newhaven nor round Beachy Head. (*The Witness produced his model of Cuckmere Haven, and pointed out the parts in which he proposed to make improvements.*)

(*Chairman.*) How far does the tide go up?—About three miles.

What depth of water do you propose to provide and render certain at low water?—Thirteen feet.

What extent of excavation should you have to make altogether?—I dare say 150 acres.

How far is Newhaven Head from the mouth of this haven?—Nine miles.

(*Mr. Walker.*) Can you make any estimate of the expense of accomplishing that which you propose?—I should think 20,000*l.* would effect it. I conceive the whole would be done by boring and by the back-water. I should bore with augers of 4 feet diameter.

How would you retain the banks if you bored the bottom away?—There are chalk hills, and the ground rises on each side the haven.

You say you have made no estimate of the expense of excavating these 150 acres so as to produce depth to the extent of 13 feet?—My opinion is that 20,000*l.* would make it accessible to vessels of 13 feet draught; if it were thought desirable to carry it further, that might be afterwards done.

The expense of effecting it, and the subsequent annual expense, must be borne by the Government?—Certainly, there are no other means. (*The Witness produced his model of the boring-machine proposed to be used, and exhibited, by working it, the mode of its operation, and its effect.*)

Do you propose to take away all the mud, or to make holes and let the backwater perform the rest?—I should not make them nearer than was necessary for the backwater to carry off the remainder, which it would do to a certain extent. (*The Witness produced his model of Newhaven Harbour, and pointed out the parts in which he proposed to make improvements.*)

(*Chairman.*) What is the eddy of Seaford Bay as it respects this harbour?—All I know is, that the shingle continues its course to the eastward.

Did you ever hear that Seaford Bay was sanding up?—Yes; I think that is very probable.

You propose, after you have bored, to keep the harbour open by sluicing?—Yes.

You propose to keep it 13 feet deep at low water at the width of 400 feet?—Yes; the sluicing would act on the deep holes made by the boring.

Have you made an estimate of the expense of this?—It appears to me, that if 15,000*l.* were laid out for three years, both might be effected, so as to see the working of the plan.

Making the expense 45,000*l.*?—Yes, for the two.

[*The Witness withdrew.*]

Adjourned till to-morrow, at 12 o'clock.

Wednesday, 8th May, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *Rich. Stuart*

8th May, 1844.

Mr. *Richard Stuart*, examined.

(*Chairman.*) In what capacity do you serve, and where?—I am a Queen's pilot, at Woolwich.

A pilot to what extent; what are your waters?—I have been generally cruizing in men-of-war, in all parts of the Channel and the North Sea.

From one extremity of the Channel to the other?—Yes, to the Land's End.

You have been also a North Sea pilot?—Yes, I have been a great deal in the North Sea.

Have you an intimate knowledge of the harbour of Dover?—Yes.

Do you frequently go into it?—Yes.

Have you ever considered the plan for enclosing the Bay of Dover with a breakwater, and converting it into a harbour?—I have heard of it; I have not considered it much in my own ideas.

Should you consider it a desirable position for the trade of the country to have a harbour?—It would be a very good position, certainly.

Do you mean Dover Roads or Dover Harbour?—Dover Roads.

What do you know of Dungeness as an anchorage?—It is a very good anchorage; with a wind from the south-west, you can ride in the bay; and in the West Bay you can ride with a wind at east-and-by-south—that is, coming along the land.

Is there a large scope of good anchorage there?—Yes, there is plenty of scope there.

What should you think of a breakwater there?—I do not know; that requires a

great deal of consideration. About making a breakwater there, it is not made altogether to secure the ship; but we must have a breakwater that the ship can get out of, as well as in—we must not tie her up.

Suppose a harbour constructed there, how would it work?—There is a long flat there; there is so much sand on both sides of the Ness.

You think there might be objections to having a breakwater or harbour there?—Yes; I do not think that it would answer.

Have you been much about Beachy Head?—Yes.

Supposing a harbour were to be constructed there, on which side of Beachy Head would you prefer it?—It has been a long time in my head that Newhaven would make the best harbour; that is the only place I can see where you can make a harbour.

When we speak of a harbour, we mean one accessible to ships of war as well as merchant-ships, at all times of tide?—Yes, just so; I think that should be provided for.

By what means do you suppose that could be effected at Newhaven Harbour?—By a pier to the westward, and a pier running out of the bay to the eastward from Seaford; the vessels would be sheltered from the heaviest of the sea, with the wind at south-east.

Have you ever been embayed on the coast between Beachy Head and Seaford?—Yes, but not but that I could get out and make an offing.

How would a merchant-ship do in such a case?—A merchant-ship would not get off if it blew hard from the southward.

To what extent must the piers be carried out to make a harbour at Newhaven?—You may carry them to any length you like; it is a regular flat all the way to Littlehampton; you may turn into what water you please. I suppose they will go out about south-south-east. I should propose a pier to the westward from Burrow Head; or it might be even further to the west than that.

You would propose it from the Fricker Rocks, perhaps?—Yes.

To what extent—600 yards?—It might go further than that.

The point shown you on the plan is 1000 yards; do you think that would make it accessible at all times?—Yes.

You have no doubt that running a pier out to the extent of 1000 yards would make the harbour accessible at all times of the tide?—I think so: what I mean to say is, that I would make a harbour of this bay; I should propose to make this bay into a harbour.

Can you make it into a harbour without some covering to the entrance?—There must be a pier at the eastward, as well to protect it from the east part of the bay.

From what part?—That depends upon the distance at which you place the piers—perhaps about Seaford; then it need not come so far out, because the water is deeper. I should propose to take in the bay. On examining the plan, I see it must not come to Seaford Head; it must be opposite to the church and mill.

From Seaford Church and Mill you would bring out the point in what direction?—It would come out into about 6 or 7 fathoms water.

Then there would be an open place along the sea-shore?—If it is felt that the space is too large, taking it from opposite the church, it can be shortened.

(*Admiral Dundas.*) If you had the choice of a refuge harbour at Beachy Head, on which side of the Head should you prefer it?—I would have it on the east side.

In Eastbourne Bay?—Yes.

What would you fix on as the point?—Somewhere about Eastbourne.

Have you ever been at an anchor there yourself?—No; but I have been cruizing many times there in a 10-gun brig.

Does the shingle move much along the coast?—No, I do not think it does, for it is mostly chalky; the rocks are chalk rocks.

There is a shoal called Holywell Bank; do you think that would form any objection to constructing a breakwater in Pevensey Bay?—No.

You would prefer a harbour off Eastbourne to having anything done at Newhaven?—I think I should, as a harbour of refuge.

Supposing you were five or six leagues to the westward of Beachy Head, and were going down Channel, and the weather looked dirty, with a south-west gale coming on, and there were piers thrown out at Newhaven, and a breakwater in Pevensey Bay, which should you run for?—I should run for the breakwater of course; to make a pier harbour is difficult for a ship: sometimes you cannot do it. If the harbour were made in the way that I have been speaking of, it would be quite a different thing.

The question supposes the harbour made as you would propose at Newhaven; that would be open to the south?—Yes.

The breakwater at Pevensey Bay would be shut up from the south-west?—Yes.

Nine months in the year the wind blows from the south-west?—Yes.

Would there not be better shelter in Pevensey Bay than any you could procure at Newhaven?—Yes, that seems to be so.

(*Chairman.*) There is a place called Foreness; do you know that?—Yes.

Is there any place you would recommend there as a harbour of refuge?—No.

You know the Brake Sand?—Yes.

Is that a good place for a harbour?—You must consider the water there three fathoms and three and a half; but as to the Brake itself, if there is water enough inside for small ships, there would not be enough for a line-of-battle ship.

Did you ever hear of the Brake Sand shifting?—Yes, always; ever since I knew it.

Mr. *Rich. Stuart.*
8th May, 1844.

Is it possible to construct a breakwater at the Goodwin Sand?—The Goodwin shifts as much as any other sand.

Would Dungeness, in your opinion, be a good place for a harbour of refuge?—No.

(*Admiral Dundas.*) What, in your opinion, is the best place for a harbour of refuge for every description of vessel between the mouth of the Thames and Beachy Head?—I should think under the Head, off Newhaven.

Looking along that side of the coast, taking Dungeness, Folkestone, Dover, Ramsgate, Margate, the Brake, the Goodwin, and Foreness, in which place of all those would you recommend a harbour of refuge to serve for all purposes?—I think to the westward of the Head.

Which, in your opinion, from Dungeness to the mouth of the Thames would be the most proper place for a harbour of refuge for steam-boats and vessels of all descriptions at all times of the tide; should you say Folkestone or Dover Bay, or what spot?—I hardly know where to say.

What is the most central spot?—It would not do round the North Foreland, for if the wind set in easterly, a ship could not get out.

The question includes all from the west of the North Foreland to Dungeness; where would you put a harbour of refuge if you had only one to provide for; in Dover Bay or Folkestone Bay, or Trinity Bay, or where, taking into view the occurrence of a war, and the necessity of protection to steamers and the collecting of convoys?—It must be about the Downs at that rate.

Why not to the westward of the Downs?—Somewhere to the westward of the Downs; I do not see any other place but Dover Bay; I think that is the only place.

You consider Dover Bay as, upon the whole, the best place looking along the coast from the river Thames to Dungeness?—Yes, I think so.

How long have you been a pilot?—25 years.

Did you ever command a vessel navigating in those parts?—Yes, in both the English and the Irish Channel.

You therefore have had an opportunity of knowing the Channel well, and what parts of the coast are the most eligible for such a construction?—Yes.

Your father was a pilot before you, was not he?—He was.

(*Sir Howard Douglas.*) Suppose there were a harbour of refuge constructed in Dover Bay, knowing as you do how Dover Harbour now fills up with shingle, would you leave the opening close to the shore or run your pier out into deep water?—You must run it out into deep water, or you could not keep it clear.

Would an entrance at the south-west be the best?—You must not have it too much to the westward, or the ships could not get out.

The central opening will face the south?—Yes, I should think so.

Would it be necessary to have two entrances, one to the eastward and another to the southward?—Yes, that might be so; I do not see why it should not.

Look at the map before you, you will see openings marked A., B., and C., do you approve of all those openings or not?—I should say two would be sufficient.

Which of the three would you shut?—The southern, C.; I should have only one to the eastward, and one to the westward.

Do not you think that, with the western opening of A., the shingle would pass through?—I do not think it would if it came out into five or six fathom water.

Would there not be less chance of the shingle passing into the harbour if A. were shut up and C. were left open?—I think it might be more apt to pass into A.

Supposing a ship coming up Channel, the wind blowing hard to the westward, the entrance at C. would be convenient and easy for her entrance?—Yes, but you must not say too much about the ease of it; the tide would be very strong across the piers.

Would it be necessary she should have a pilot?—No, she would not require a pilot; it is only entering between the two piers, and if they cannot keep clear of the piers, it is their own fault.

What distance should you propose between the pier heads?—I think about 700 or 800 feet; I think that would be required for the ship to work out.

What is your opinion of B. to the eastward?—She could go out there of course.

If the wind came round, she could go out at B.?—Yes, certainly.

Upon the whole, which do you consider the two best approaches to that harbour, supposing only two were made, whether A., B., or C.?—I would take C. southern for one and B. eastern for the other.

Why do you require a space of 800 for the opening?—I do not think that it need be so wide if there are two openings.

Tug-vessels might be had if necessary?—Yes; I think 400 feet would be quite enough.

400 feet for the large opening?—Yes.

(*Captain Fisher.*) You have stated that you have been in the habit of taking vessels as a pilot from the river Thames; how far have you gone?—To the Land's End.

How long have you been employed in performing that duty?—Twenty-four years.

What is your opinion, supposing only one harbour of refuge were to be provided, as to the best position between the Downs and Portsmouth for that harbour of refuge, bearing in mind that it should be accessible at all times of the tide for ships-of-war as well merchant-men?—The bay east of Beachy Head will not do for a line-of-battle ship; in my opinion it must be in Seaford Bay.

Have the goodness to state your reasons for giving the preference to Seaford Bay?—My reasons are on account of the water required for line-of-battle ships.

Which of the situations, supposing a harbour to be constructed to the east of Beachy Head, between Margate and Foreness, within the Brake Sand, Dover Bay, Dungeness Bay, Eastbourne or Pevensey Bay, would you prefer, taking into account both coming and going, and all ships that might require to use it?—For line-of-battle ships it must be on the west of Beachy Head; I should say Seaford Bay.

Seaford Bay in preference to any of the other of the situations?—Yes.

Having stated that Seaford Bay would be the best place in your opinion as a pilot for ships, some homeward bound, and others outward bound, finding themselves in a situation requiring shelter, would there not be great risk of their getting embayed by running for a harbour made at Newhaven?—No, I should think not, for no persons would attempt to run unless they could get into that harbour.

Have you not been in situations in which you could have found refuge if a harbour had been constructed, either under Dungeness, or in Dover Bay, when you might have been prevented running for Newhaven?—No, I think not; I cannot see any place to equal it.

Supposing yourself a pilot in the Admiral's ship, with ten sail of the line, the wind blowing hard on shore, would you advise the running down on the lee-shore into this port, especially if the weather were at all thick?—Yes; but I should not attempt to run for it if the weather was thick.

If it came on thick, would you not get embayed there?—Then I should haul off again.

As a pilot of long experience, which the Commissioners understand you are, do you suppose there would not be much greater risk with a strong westerly wind in running for a harbour of refuge in Seaford Bay than for a harbour of refuge in Dover Bay?—I think not; I think Seaford Bay would be the best; I speak as to the ship getting to sea as well as getting in, with easterly or westerly winds.

You think, taking into consideration all circumstances, that Seaford Bay is to be preferred?—Yes.

(*Chairman.*) If a breakwater were constructed in Seaford Bay, would it be a great advantage to the harbour of Newhaven?—I should think it would be a very great advantage.

Would it make Newhaven available at times when it is not available at present?—Decidedly.

Would it also be an advantage to Cuckmere?—No, I do not think it would be of any advantage to Cuckmere: Cuckmere grows up completely in time; there is scarcely any opening at all.

You think that if there was a breakwater in that situation, there would be an advantage in the breakwater having Newhaven inside it, and that the breakwater itself would be an advantage to Newhaven, that there would be a mutual advantage?—I think so.

(*Sir W. Symonds.*) Supposing you were acting as pilot of a ship, and that you could not fetch into a harbour of refuge at Seaford, you must of course go higher up for refuge?—Yes.

Where should you take refuge higher up, provided a large breakwater a mile and a half long, and carried to any extent that might be considered desirable, were erected, where is the place where you would take shelter in ground where you could anchor without driving?—You might make a breakwater at Dungeness in the East Bay.

Is the holding-ground good in the East Bay?—Yes, very good.

Of what does it consist?—It is blue clay and sand, forming good holding-ground.

As good as the Downs?—Yes, better.

You say that the point would shelter you from the south-west winds?—Yes, there you will be in about three fathoms and a quarter water, the light bearing south-west.

You would recommend a breakwater to be formed to give you shelter from the south-west round southerly to the bearing of the Foreland, so as to bring in the northern end of the breakwater?—No, it must not go only to the direction of the Foreland, for that would be east-north-east; it must go more to the north-eastward.

What is the nature of the ground for anchoring in Dover Bay?—It is sand and chalk.

Along the line of the breakwater you saw on the plan just now, is the whole sand and chalk?—No, shingle as well in shore.

Is that good holding-ground, as good as that of Dungeness?—No, nor yet as the Downs.

You were understood to say that Dover is not so good as Dungeness or the Downs?—Neither Dover nor the Downs are so good as Dungeness; but I have been riding with a ten-gun brig in Dungeness Bay, and have been obliged to slip.

If Dover Bay were enclosed with the large breakwater which you saw on the plan, and you entered it in a large ship, should you feel confidence in the anchor holding when there was a heavy gale of wind blowing, considering the contracted space within that harbour, and do you think a large ship, a line-of-battle ship, anchored immediately on entering the pier heads, would have room to bring up, a great many vessels having taken refuge there besides?—She might bring up; but the query is whether she would not strike.

(*Chairman.*) Would she drive up hill?—Yes, she would drive up hill.

Mr. *Rich. Stuart.*

8th May, 1844.

Is there any difficulty in bringing up a ship in that anchorage supposing you carried out in 7 fathom water?—There is no difficulty in bringing up the ship; but when it blows hard, I do not think a line-of-battle ship would ever take it.

What is the objection?—If it blows a gale of wind, and I let go my second anchor, I cannot give her any cable.

Supposing a breakwater to be made at Dungeness, would not the same difficulty exist as to the space for bringing a ship up?—I am of opinion that a line-of-battle ship never would enter there.

Suppose you were coming up in a gale of wind, with the wind at W.S.W., would you take a harbour of refuge there, or go for the Downs?—I should go for the Downs; the place is too narrow for a line-of-battle ship.

Some of the questions have put an extreme case to you with respect to a line-of-battle ship; suppose the harbour to be only for frigates and for squadrons of steamers, should you see any objection to it in that point of view?—Oh, no; not at all.

Were you ever upon the Royal Sovereign Shoal?—Yes; I have been over it many times, not touching it with the ship.

What sized shoal is that?—Really I cannot say; but I think there is more water upon it than is generally supposed.

What number of feet at low water?—I think there is not less than 16 feet.

What is the extent of that shoal?—I suppose about a quarter of a mile or half a mile.

Do you think it is chalk or sand?—I think it is chalk.

What is the distance from the Sovereign Shoal to Beachy Head?—About five miles and a half to six miles.

Supposing there were a harbour of refuge to the east, or under Beachy Head, do not you think a ship could get shelter at any time of the night or day?—Yes; but I am not putting the case of a line-of-battle ship; it is a very narrow place; there is a great deal of foul ground within side of the bay.

Of what nature?—There are a great many chalk rocks in the inside to the eastward of the Head.

Do you mean in Pevensey Bay?—No; to the northward and eastward of the shoal.

The Ratton and other shoals?—Yes.

(*Admiral Dundas.*) Supposing you were a pilot of a ship in a hard gale of wind, and you wanted to bear up for refuge, the wind being at south-west, that you had a breakwater off Seaford which is to leeward, and another off the Head which is sheltered from the south-west gales, which should you prefer to run for?—If I was bound down Channel, I should go to the westward; to Seaford, certainly.

What holding-ground is there at Seaford?—The ground is very good holding-ground.

What sort of ground is there in Eastbourne Bay?—I never was riding off Eastbourne.

There is plenty of room inside at Eastbourne?—Yes, for a 10-gun brig.

(*Captain Fisher*) Supposing you were running up Channel, being to leeward of Beachy Head, even if a breakwater were formed either to the eastward or the westward of Beachy Head, and you had to bear up, having said that you would anchor at Dungeness, with the wind at south-west, and that there is good holding-ground there, should you in that case anchor at Dungeness, with the chance of having to slip and run into the Downs if the wind came further round to the southward; or would you, in the event of there being a harbour formed at Dover, run for it, in a large frigate or a large steam-vessel-of-war, a great many vessels, probably 100, having taken shelter there?—I think I should take Dungeness.

The question supposes there was not a breakwater at Dungeness, but that there was one at Dover?—Then I should go on to the new harbour of Dover.

You would do so in a large steamer or frigate?—Yes.

(*Captain Washington.*) For vessels coming from the North Sea, and bound to London, or to the westward that do not come through the Swin, where would be the most useful harbour of refuge?—They must come into the Channel.

Do not many ships coming from the Baltic make the land at the North Foreland?—Yes, but not if they are bound down Channel, unless they are blown across; it is only the vessels from Holland or Antwerp or those places that make the Foreland; but the Baltic ships, or those from the northward, unless they are blown away, never come across the Kent.

Where do they make the land?—They generally make the land at Lowestoft; very often at Flamborough Head.

Would a harbour of refuge, enclosing Margate Roads from Foreness, be of great use to shipping generally?—I cannot see that it would myself; they might as well extend Margate Harbour, and make that a harbour of refuge.

Would that be of any very great use to the trade of London?—I cannot see that it would, with the wind easterly.

Do not ships that break away from their anchors in the Downs often seek shelter in Margate Roads?—Yes.

Supposing the wind to come from the eastward, are they not exposed to the whole of it?—Yes; they are.

Still you do not consider a harbour there necessary?—No; I do not.

Mr. *Rich. Stuart.*

8th May, 1844.

Is the anchorage between Margate and Margate Sand good holding-ground generally?—It is hard ground, chalky ground.

You say you have known the Brake as a shifting sand, have the buoys been shifted often within your memory?—Yes.

How long have you known the Brake to be a shifting sand, ten or twelve years?—Yes; longer than that.

Is it moving any particular way?—I can scarcely say which way it is moving, unless I were always looking after it. I see it is moving by the broken water in crossing it.

(*Chairman.*) It appears from Captain Bullock's survey that the Brake Sand has moved 700 yards to the westward, its whole length; were you, as a pilot, aware of that?—Yes.

What time has that change taken in effecting?—It has been altering a very long time, these 14 or 15 years to my knowledge.

You have known it that time?—I have known it these 30 years.

How often have you known the south buoy to be shifted?—I do not think the south buoy has been shifted, it is the middle buoy; you can go with a frigate between the south buoy and the shoal; I have crossed it with a frigate.

(*Sir H. Pelly.*) What is the depth of water at low-water spring-tides within the Brake?—I think there is about 3 fathoms or 2½ at the upper end.

What will be the depth of the water in the middle of the anchorage?—About five fathoms, to the southward.

Where would be 18 to 21 feet?—Towards Ramsgate, to the northward; to the southward the water deepens.

Do you think there would be any difficulty in constructing a harbour of refuge enclosing the Little Downs within the Brake?—I cannot answer that question.

Do you think there would be sufficient anchorage, supposing a harbour constructed there, for 100 sail?—I think not, unless you take in the whole of the Brake.

(*Captain Washington.*) Looking at the proposed breakwater in Dover Bay, if made with only one entrance, are you of opinion that there would be any difficulty in ships such as the "Vernon" and the "Medea," and the heaviest merchant-ships getting in there or working out at any time, the entrance being 800 feet wide?—I do not see that there would.

(*Chairman.*) Supposing the wind at west, and the vessel anchored near the eastern end, and a good many vessels lying at anchor?—They would not turn; there would not be sufficient room for them to turn.

Perhaps you think there should be two entrances?—No, I do not.

Do you think ships would not ride there in safety with half a cable out in a heavy gale of wind; would they require more than half a cable to ride in safety?—Yes; with a heavy gale of wind blowing; if it blew a heavy gale of wind, I think that would not be sufficient. I have been in a merchant-ship and have got my cables a-shore to hold her in Dover Harbour as it is.

She would require a whole cable?—Yes; or two halves.

Can ships ride in Dungeness East Bay during an easterly gale?—No; they cannot.

If they came to Eastbourne Bay to the eastward of Beachy Head, in a south-west gale, would the Holywell Bank be any defence against the sea setting into the bay?—Of course it would break the sea, and be some protection.

With the Royal Sovereign shoals lying about three miles and a-half off shore, would there be any difficulty in ships running out to the eastward from a harbour in Eastbourne Bay?—Yes; with line-of-battle ships there would.

Confine yourself to large-class steamers and frigates, and large merchant-ships?—The largest merchant-ships would not run in.

Within the breakwater in Seaford Bay, Seaford Head would bear south-east —Yes.

You still think there would be no difficulty in running for that harbour in a south-west gale?—I do not think there would be any difficulty.

And you think there would be no danger?—No.

(*Captain Washington*). You would not consider it dangerous in a south-west gale to run for a harbour of refuge in Seaford Bay, remembering that Seaford Head bears south-east-half-east, at two miles and a half distance?—No.

Your great objection to a harbour at the eastward of Beachy Head arises from the Sovereign Shoal, does it not?—Not altogether from that, but from the shoal water there is inside of it for large ships.

You do not mean merchant ships?—There is room for merchant-ships in general; but a large merchant-ship, an East Indiaman, for instance, drawing 22 feet water would not attempt to go inside the Sovereign.

Not even for a harbour of refuge?—No.

What should you, as pilot, do in such a case?—I should go to the Downs or down Channel, or to Margate Roads, round the Foreland.

(*Captain Fisher.*) Supposing you were on board a less ship than an Indiaman, and there was a gale, and you wanted to get refuge for the night, and there was a breakwater under the Head, would you prefer a breakwater to the east or the west of the Head?—If bound down Channel, I would prefer one to the west of the Head.

That is to say, at Seaford?—Yes.

All our harbours in this part of the Channel are tide harbours?—Yes.

In case of a war, it would be necessary to have steamers ready to slip out at a moment's notice; where, in your opinion, is the most eligible place for a breakwater to be

Mr. *Rich. Stuart.*
8th May, 1844.

constructed for those steamers to lie protected from the enemy?—Dungeness and Dover are the narrowest parts of the Channel.

Which should you prefer, considering that the protection of the vessels would be an object?—Dover would certainly be better for protection than Dungeness.

What is your reply, taking the whole question together?—Then I should say Dover.

(*Adm. Dundas.*) If that breakwater, which it might be necessary to construct for the protection of steam-vessels, were made to protect the trade also, would not that be a great advantage to the country?—Certainly; they could make a battery of it if they liked.

Do you think that Dover is the most eligible place to contain steam-vessels acting against the enemy for the protection of trade, and for shelter to merchant-ships?—No, I should say Newhaven is the best for merchant-ships.

Take the case of the narrow seas?—Very near there I have seen a dozen sail of privateers off Beachy Head at one time.

Next to Dover, what should you say is the best place as a place for a squadron of steamers, and at the same time for protection?—There is only Dungeness that I know of, till we get lower down; the east of the Head would do as well as the west as to steamers.

Are you to be understood still to adhere to Seaford Bay as being the best situation for a single harbour of refuge to be constructed, if there is only one?—Yes.

(*Capt. Fisher.*) In your opinion, as a pilot of long standing and great experience, where would you recommend a second one to be placed, supposing it were determined to have two?—At Dover.

In answer to a question put to you respecting the Brake Sand, you said you had known it for fifteen or twenty years; do you know whether the marks for running up for the Little Downs, inside the Brake Sand to Ramsgate Harbour, have ever been altered?—No, we use the same marks.

Do you know the turning marks to have been altered?—No, I turn by the same marks.

(*Capt. Washington.*) Supposing a vessel running down Channel with a south-east wind, if the wind shifts to the south-west and comes on to blow hard, would it not often occur that they could get shelter to the east of Beachy Head, when they could not get round it?—The large ones would bear up for the Downs.

(*Chairman.*) Supposing a war to break out, and a harbour to be formed immediately for steamers to meet the enemy and protect the commerce of the country, where would you build that breakwater—at Seaford or at Dover?—I should think Newhaven, Seaford Roads.

Where were you born?—I was born at Harwich.

You are now living at Woolwich?—I have been at Woolwich seven years.

Where did you live before that?—At Harwich; I have been in the service 24 years, and have always been away from my home till now.

You have never resided down to the West?—No.

[*The Witness withdrew.*]

Mr. *Fortunatus Pellatt.*

Mr. *Fortunatus Pellatt*, examined.

(*Chairman.*) What are you?—I am master of an Ordnance sloop.

How long have you been a navigator of the English Channel?—I have been up and down many years. I have been master of a coasting-vessel upwards of twenty years.

Between what places?—Between the river Thames and Portsmouth and Plymouth, and across to Ireland occasionally.

Have you ever been in difficulty and distress for want of a harbour of refuge in the neighbourhood of Beachy Head?—We have often had occasion to run back to the Downs when we have been to the westward of Beachy Head between that and the Owers.

If there had been a harbour constructed in the neighbourhood of Eastbourne, you would have found it a shelter, and have been glad to run for it?—Yes.

(*Admiral Dundas.*) Supposing you had the choice of a situation for a harbour of refuge, where would you place it, taking into consideration the convenience of the trade in general, and at the same time the accommodation of squadrons of steamers, the same being accessible at all times of the tide?—Newhaven is a very good harbour, but it would require the existence of a breakwater to cover it.

Do you mean by Newhaven that you would enclose Seaford Bay by a breakwater?—Yes, or it would not be an outlet as well as an inlet.

Which on the whole do you consider as the best?—I consider that Newhaven would not answer unless it was covered by a breakwater.

Do you mean that you think that would be the best?—I think it would be a good situation.

On which side of Beachy Head would you prefer the harbour if you had to fix the situation?—On the west side for an outlet.

Would not vessels have a difficulty in getting out of that bay if they wanted to get out when it moderated?—With an easterly wind, they could get out much better than if it were to the westward.

Mr. *Fortunatus Pellatt.*

8th May, 1844.

(*Chairman.*) Are you accquainted with the anchorage about Dover Bay?—Yes.

What sort of holding-ground is it?—It is not very good; it is very indifferent holding-ground, and the water runs steep close in.

What sort of holding-ground is it at six or seven fathoms?—It is not very good holding-ground there.

Have you often anchored in it?—I have often in six or seven fathoms. We go very close in. It is only anchorage for small vessels. I have anchored also in deeper water, but it is not considered good anchoring-ground in Dover Roads.

What is the anchorage north of Dungeness?—That is very good holding-ground, but the water is very shallow there, and they have a shoal that runs all the way up along the land, but they have a very good place just below Romney; between Romney and the Upper Batteries there is a place falls in there, just below the Swallow Bank, which would form a harbour. There is a bight runs in there, a great piece of water in there.

Have you ever served as a pilot, or only in command of a vessel?—Only in the command of a vessel. I have been master of a coasting-vessel.

Have you always piloted your own vessel?—Oh, yes.

Have you been acquainted with the anchorage between the Brake Sand and the Small Downs?—Yes.

Have you any knowledge of the depth of water vessels anchor in generally?—Five, six, and seven fathoms.

Have you ever been aware of the Brake Sand shifting?—No; but I am aware, there are several small patches without it and within it.

Are those patches formed by the shallow water inside?—In many parts.

What depth of water is there on those patches?—Some of them not more than two fathoms and a half and three fathoms at low tide.

Have you ever known the middle buoy of the Brake to be shifted in consequence of a change of the sand?—No; I know there has been a buoy placed there a little while ago, a chequered buoy, that did not used to be there on a knoll.

How long ago was that placed?—I think within the last two years.

How much is that within the middle Brake-buoy?—This is on the elbow of the Brake. It has been only recently laid there. There was no middle Brake buoy there formerly.

Do you know anything about Foreness Harbour?—Yes.

Is that a position where a harbour of refuge would be of any use?—I think not.

Do you know the Goodwin Sands?—I know them very well; Trinity Bay.

Do you think it possible to make a harbour there?—I think for such a place as the Downs, with a chalk bottom, it would be a very good place.

Do you think that in Dover Bay a good harbour might be made?—No; I think not.

What do you think of Dungeness?—I think they might make a good harbour at Dungeness, equal to the demands of the merchant-ships and trading-vessels, there being no shelter from the Isle of Wight to the Downs but Dungeness; under Beachy Head there is no shelter, which there is under the Ness.

(*Adm. Dundas.*) All these questions are put upon the presumption of the thing being to be made. Supposing a harbour, or two harbours, to be formed for the protection of the trade of England, and also in case of war, that steamers might be ready to protect them, in what position, Margate, Ramsgate, Deal, the Brake, Dover, Dungeness, Beachy Head, either one or the other, what place would you select?—I should say it must be either Newhaven or to the eastward of the Head between that and Pevensey Point.

In case of war, as it would be necessary to keep steamers in readiness to slip out at short notice, which is the most eligible place for a breakwater to be constructed for those steam vessels to lie protected from all winds?—I should say Trinity Bay.

Wherever they lay there must be an opportunity of getting their coals on board?—If such a thing was to be, that a breakwater was to be erected, or a harbour made, there would no doubt be a place made as well as a fortification, and a landing for coals.

In the Goodwin Sands?—Yes.

What is your objection to eastward of the Head?—Because I think it would take such an extent of ground; the water runs off very shallow, you can go within half a mile of the shore, and go off seven or eight fathoms water.

You are not afraid of the Sovereign Shoal?—No; there is plenty of room between that and the Sovereign Shoal.

Suppose a breakwater formed there, with a light on the Head and a light on the intended breakwater, could any ship run for it?—Yes.

Would that be a preferable place to a breakwater off Seaford?—I think that it would be best to the eastward of the Head.

Suppose a breakwater formed under the Head, what are you afraid of in running out?—There is nothing to be afraid of in running out.

Suppose I am anchoring there and want to go up Channel, is there anything to prevent my going through the eastern channel?—No.

Do you conceive that that is the best place for a rendezvous and asylum for vessels, whether coasting or waiting for a wind, or for armed steamers ready to slip?—I think that would be the most eligible situation, in consequence of the other being a bar harbour.

Mr. *Fortunatus Pellatt.*

8th May, 1844.

The questions suppose a harbour to be built, suppose a breakwater formed to the east of the Head, lighted, as was mentioned, and that you had a breakwater formed like the one at Plymouth, off Seaford, and you were in a ship two or three leagues to the westward and a dirty night coming on, where should you bear up?—For the one to the eastward, in consequence of the shelter of the Head.

(*Sir H. Pelly.*) You stated that Trinity Bay would be the best place for a harbour, supposing you could not make it in Trinity Bay, is there no part of the Downs in which it could be made?—I do not see any in the Small Downs; there is not an opportunity for a vessel getting out. As you approach Ramsgate, you get into very little water; and in placing a harbour there I do not see how she could get out.

Take it lower down towards Deal and Walmer?—Then I do not see how a vessel can get out when it is blowing a gale of wind.

What would prevent her getting out of one just as well as out of the other?—The one to the eastward of the Head is an open space, as the one in the Downs. Unless it is below Walmer, I do not see how they could get out; if it was down off Walmer, they might have a chance; but I think if it is a fog, and particularly in the night time, I do not apprehend they could get out in the night time.

(*Chairman.*) Suppose a vessel to be at anchor within the Brake, that she cannot get to the northward because of the shallow water, and a gale sets in from the south-west, she would not be able to get round the south end of the Brake?—No.

Therefore she must ride it out?—Yes, that is what I mean.

Have you ever gone over the shallow water between the Brake and Ramsgate?—Yes.

What depth of water have you got?—There is one part where you see the sea break; it is dry at low water. I have seen it all dry, and have seen a ship lost there when I have been at Ramsgate.

Are there not two channels out to the northward?—Yes; but the Old South Passage is not fit for a ship at low water; sometimes there are nine, or ten, or eleven feet only, and it must be people who are continually in and out to find it out. There is not a passage for any but small vessels which are running for Ramsgate; there is only nine or ten feet.

Did you ever anchor in Trinity Bay?—No, but I see how it is situated; I have been close inside of the Gull Stream there.

You form your opinion of the harbour there from what you have seen, not from having been in it?—Yes.

Are you acquainted with Mr. Bush, the civil engineer?—No.

(*Captain Fisher.*) The Commissioners understand that you have been for 20 years master of a coasting-vessel?—More than that.

On what part of the coast would you prefer having a harbour of refuge constructed that should give ample protection to vessels bound either down or up Channel from the river Thames as far as the Isle of Wight?—I should say in Eastbourne.

Did you not state that you considered Newhaven, covered with a breakwater, would be best?—Yes; but the other would be the most eligible situation if it was intended for ships to go in and out either way.

If there was to be one harbour of refuge constructed for ships of every class, it should be one to the eastward of Beachy Head?—Yes.

Do you consider that a harbour constructed there would be accessible to vessels of all descriptions, men-of-war as well as merchant-ships, either in bad weather or by way of protection from an enemy during the night?—Yes, I think it would.

You would prefer that situation to a harbour constructed in Dover Roads or under Dungeness?—I think that is preferable.

Are you of opinion that a safe and good anchorage might be made anywhere between the Brake Sand and the beach?—Yes, it might be made in any water; but I do not mean to say that there would be an outlet in any water. A vessel could not get out at certain times.

As the entrance to the Brake must lie open to the south, what protection could they have to the anchorage?—None, unless the breakwater went with a sweep.

Then the breakwater must come in more towards the shore?—Yes.

Unless the front of it is covered, it must be an open anchorage?—Certainly.

A breakwater being carried so as to cover it from the south-west to the south-east wind would make it a complete harbour?—Yes.

In your opinion, with a breakwater or a shelter constructed on the north part of the Deal Sands, or any part of the Brake, would there be an opening sufficient for ships to go to sea to the westward?—In a gale of wind, I do not apprehend there would be room enough for a ship to go to sea; supposing the wind blowing south-south-west, she could not get out; there is not water enough for a vessel to get out at low water.

There is good anchorage, but, in your opinion, no means of getting a vessel to sea?—Yes.

If a pier were thrown out from the shore, would it not make a great drift of tide?—It would make more current; the tide runs very rapidly there.

At what rate does the tide run?—I suppose, in spring-tides, three knots or three and a half.

Do you mean in the Small Downs?—No, it runs in the Small Downs from two to two and a half.

Mr. *Fortunatus Fellatt.*

8th May, 1844.

(*Chairman.*) Do you wish the Commissioners to understand, that by narrowing the passage you would get a greater rush of the tide?—Of course.

Suppose an enemy's vessel off the North Foreland, and our vessels are lying inside this breakwater at the Brake, must our vessels come to the southward of the breakwater before they can get to the North Foreland?—Yes; supposing it to be low water, there is no other passage.

Supposing an enemy's vessel to be off the North Foreland, she would not be able to get in at this passage any more than our vessels could get out?—No.

Are you aware whether there is water enough for the Ramsgate steamers to go out through the North Channel at low water?—Yes; those small steam-boats that use Ramsgate.

What draught of water?—They draw from six to seven feet, some of them may draw eight, but the average of them not more than six or seven feet.

Do you know the least depth at low water?—From nine to ten feet, it is very narrow then.

There is the Cliff Channel also?—That is one that is not used except by the fishermen, and that only at particular times, the Old Cudd Channel is that generally used.

Where were you born?—At Purfleet, in Essex.

Where do you reside?—In Woolwich; I have resided there these 30 years.

[*The Witness withdrew.*]

Mr. *John Meckiff*, examined.

Mr *John Meckiff.*

(*Admiral Dundas.*) What is your occupation?—Master of the "Lord Vivian" Ordnance vessel.

How long have you been in Channel navigation?—About 17 or 18 years, I have been to and fro in the Channel.

As a pilot?—No; in the Ordnance.

With what part of the Channel are you mostly acquainted?—Portsmouth and Plymouth; from the river to those places.

You have been to Dublin?—Yes; I am bound to Dublin now.

In navigating the Channel in bad weather, in winter time, if you had the choice of having a harbour constructed anywhere, where would you think it would be most convenient, between Portsmouth and the North Foreland, having reference to the trade in general?—I never was in anything but those Ordnance vessels; you might make a very good harbour to the east of Beachy Head, that would be a very good place.

Would you have any apprehension of inconvenience from the Royal Sovereign Shoal, and the other shoals?—There is nearly or quite three fathoms on the Royal Sovereign Shoal.

What does your vessel draw?—11 feet when she is loaded.

Supposing vessels lying at anchor behind a breakwater at Eastbourne, and having occasion to come out at the other end would, there be any inconvenience?—A smart vessel would go out either at one end or the other, down to the Head or up to the Ness.

You would not have any hesitation in getting her out, and going round in shore of the Royal Sovereign?—No.

With any description of vessels?—I would not try it with a large vessel; but with a merchant-ship, drawing 18 feet, I would.

This is meant to be a shelter for the trade in general?—I know very little of large ships, I do not understand anything about them. I have never been used to be in one.

You would have no objection in taking charge of a large ship?—I should like to go in one before I took charge of her; I have never been in a square ship in my life, nor my father before me; I have always been in those small Ordnance vessels.

You would prefer a breakwater to the east of Beachy Head to any other?—Yes.

Suppose that a harbour were to be provided for a squadron of steamers for the protection of trade, and the purpose of watching the enemy, what situation should you prefer next to Eastbourne?—They might form a very good harbour at Dungeness.

In case of a war, it would be necessary to have steamers ready to slip out at a moment's notice to protect the trade, and also to have a place where they would be protected from attack. Now, looking at the whole Channel from the Downs, in what place would you prefer to have a squadron of steamers?—I think the Ness would be a very good place for it, either the one side or the other; the east side of the Ness would be best perhaps.

You mean for a second harbour?—Yes.

Did you ever hear of Trinity Bay in the Goodwin?—I have heard tell of it, but never knew it.

The Brake?—I believe I have.

Could a harbour be constructed there?—There might be; there would be no back-passage out of it.

Do you know Foreness?—Off the North Foreland there is a rock called the Foreness Rock.

Is that an eligible place for a harbour?—Is is a very straight shore there.

What do you think of Dover for a harbour of refuge?—You might form a breakwater in front of the harbour.

Mr. *John Meckiff.*

8th May, 1844.

How is the holding-ground in Dover Bay?—Very good holding-ground, a little further off we generally anchor in seven or eight fathoms; that is very good holding-ground.

(*Sir W. Symonds.*) Would you prefer, for steamers, Dover to Dungeness, or Dungeness to Dover?—I should think Dungeness would be the snuggest of the two.

Will you state what are the reasons why you prefer Dungeness?—I think there would be a good entrance either way.

Do you consider the holding-ground better?—There is very good holding-ground at the Ness, it is clay ground.

(*Chairman.*) You give the preference to Eastbourne Bay above other places, and to Dungeness in preference to Dover?—Yes.

Where do you reside?—At Woolwich.

Where were you born?—At Portsmouth.

[*The Witness withdrew.*]

Mr. *William Bush.*

Mr. *William Bush*, examined.

(*Chairman.*) Are you a civil engineer?—Yes.

How long have you been in that occupation?—About five and thirty years.

You were bred to it?—Yes.

Have you ever been at sea?—Yes, I have been at sea; I was in Calcutta five and thirty years ago, as an engineer; I was then under Colonel Gascoigne.

Have you a plan of a harbour which you propose to construct by means of iron caissons on the substratum of the Goodwin Sands?—I have.

Have you your plan here?—I have. (*The witness produced the same.*)

To what depth have you bored on the Goodwin Sands, and what is the nature of the substratum on which you propose to rest your caissons?—The caisson was sunk through the sand eight and twenty feet. We did not bore at all; we got down to 28 feet; there we could see the milky substance of the chalk within the caisson.

Do you propose that the caisson should find its own way by its weight?—Yes. This is the drawing; it is like one diving-bell working on another, and there are the air-pumps, with men working on another. This is the model of it (*producing the same*). Here is sufficient air in the chamber to last a dozen men for a day, and to prevent the loss of the air; they come through the man-hole. (*The witness pointed out the mode of operation.*)

It appears that you have already sunk a caisson?—Yes.

Of what dimensions?—Thirty feet diameter.

Is this on the same plan as the caisson which you had on Deal Beach?—Exactly the same.

What has become of the caisson which you sunk?—It was carried away in a gale of wind, on the 24th October, 1842.

Swept bodily away?—Yes. It is supposed that the "Nancy" run foul of it; but I was not there at the time.

If you were authorized to carry on such a work, should not you have a constant apprehension of its being carried away?—Of course I should now be more careful, for I should put a light upon it.

That is assuming that it was run foul of?—Yes.

But you do not know that it was run foul of?—I received a letter from Lieutenant Batt that he saw this vessel very near it, and that it was lost.

When you sink your caissons, is there not danger of their being carried away as this was?—I should say not; there was 10,000 to 1 that it should never be swept away.

Your plan is to surround the whole of the Goodwin Sands?—Not the whole of it.

You propose to surround 2000 acres?—Yes; the other side is deep water. On the back of the Goodwin there is 100 feet of water, and by raising an embankment of 12 feet high it would fill up; the Sand would fill up after this embankment.

You propose to surround the Sand by caissons?—Yes.

Your object is to form the Goodwin Sands into an island?—Yes, or into an harbour of refuge; there is 2060 acres of water there, which would be the finest harbour in the world if it were carried out.

Besides the caissons which you would use in surrounding these Sands to make an island, you would use your caissons to make a harbour?—I should go on 100 feet at a time; I propose they should be formed in the dock-yard, 100 feet in length, and floated out. We had every disadvantage on the beach, because we could not get them off the beach after we built them.

As your caissons are intended to be carried out 11 miles, have you ever estimated the number of caissons that would be required for that?—Yes.

How many?—I have not my papers with me, but there would be 53 in a mile.

That would make 583?—Yes.

You say, in your papers, that you would undertake it at your own cost, with the assistance from the dock-yards?—That is for one caisson of 100 feet to show the principle.

You are understood, in your Report, to say that you would undertake this work at your own cost, with the exception of certain assistance to be given to you by Her Majesty's

dock-yards, what is the nature of the assistance which you would expect from the dock-yards?—The dock to build it, and to float it out. Mr. *William Bush.*

Is that all that you would require?—With the assistance of a steamer to tow it out. 8th May, 1844.

Do you mean that you would undertake the expense of surrounding this island?—No, that was the expense of one caisson, to show the principle, before Government votes a large sum of money for a harbour of refuge, to show that it can be carried out; when that is shown, they may add to it, and carry it out.

What sum of money do you suppose it would require?—It comes to about 800,000*l.* per mile, or from that to 1,000,000*l.* a mile. The caisson I constructed cost me about 2*s.* a cubic foot.

It would cost 8,000,000*l.* altogether?—Yes. There is plenty of shingle to fill it up with cement and shingle.

Have you never estimated the expense you suppose it would cost, when you propose this work?—Yes, about 8,800,000*l.*, or about 800,000*l.* per mile.

What is the ultimate object you propose by converting it into an island?—To obtain a harbour.

How long were you building the caisson which you sunk?—We were about six or eight months building it.

Suppose a work of that kind to be undertaken for 11 miles in extent, how many years would you give for it?—It would depend on circumstances, and on the supply of money.

Suppose the money to be found?—If you once form the nucleus you could go on at different parts, and expend 1,000,000*l.* a year.

(*Admiral Dundas.*) How many years would it take to complete it?—Eight or ten years

Supposing Government found it impossible to undertake this great work, where, in your opinion, would be the next best place, between the River and Portsmouth, to form a harbour, which would combine two things, protection to the commerce of the country and a station where steam-boats could be congregated to slip out and annoy the enemy?—I hardly know a place which is fit for it, unless there was a breakwater carried out; then it might be placed at Newhaven. I should say it should be the centre of the Downs.

Do you know anything about the south-east coast?—Yes; I know all the coast.

In what part of the Downs?—I should say opposite to Deal is the best place to take out a breakwater.

Do you prefer that to its being further to the westward?—I do not know, I am sure; Portsmouth is so near a point if a vessel was outward-bound; or inward-bound she would wish to get into the Downs.

Suppose a war broke out, and you wanted your steamers to be ready at a moment's notice, all the present harbours are tide-harbours; we want a breakwater-harbour, where vessels might be lying ready to slip out in an instant, and a place where merchants could find refuge in a gale of wind. Where would you place it, between the Downs and Portsmouth?—I should say on the Brake, or the Ridge, or the Varne; that there might be a breakwater built.

(*Captain Washington.*) Do you remember the situation of the Varne?—Yes.

What would be the object of building a breakwater there?—It might be a shelter for ships.

(*Chairman.*) Putting aside the Goodwin and the Ridge or Varne, and looking to the various places on the coast, what part of all the places, Dover, Folkstone, Dungeness, and either side of Beachy Head, should you recommend?—I do not see any place on that part of the coast where it would be any advantage for a ship to run out.

The question supposes a breakwater to be made?—I do not know any place at all where it could be carried out to any advantage.

Suppose a breakwater at Dover, what do you think of that?—I do not think that would do at all. I do not approve of Dover for a harbour at all.

Have you seen a plan of the breakwater? (*It being shown to the Witness*).—That is a very good plan; but I do not see why a harbour is required there, for I should never go into Dover. If I were going to the East or West Indies, I should run down Channel.

(*Admiral Dundas.*) Suppose a war to-morrow, and there was protection wanted for steamers?—Then Dover would have a great advantage, being a fortification for protection, but not as a harbour of refuge.

Where would you place a harbour where steam-vessels could lie ready to slip out at a moment's notice, and where vessels could lie wind-bound in a gale of wind?—I should say Dover is far preferable to any other place that I know in some respects. It would do for men-of-war. We want, in case of war, a place where we could run in our large ships; but if we were in the Downs, we might run either way. For a fortified harbour, of course Dover would be far superior to any other place.

If you formed a breakwater, on which side of Beachy Head should you form it; eastward or westward?—It might be built I suppose somewhere about Hythe. Beachy Head, I should say, is too near Portsmouth.

Do you offer your opinion to the Commissioners as a seaman in respect of the maritime position of the harbour, or as a engineer?—I do not offer my opinion as a seaman; I know the coast pretty well.

(*Mr. Walker.*) In what character do you offer your opinion as to the position of a harbour of refuge?—As an engineer.

Mr. *William Bush.*

8th May, 1844.

How long were you constructing your caisson before it was carried out?—Eight months.

Were not you there two years?—Yes; the first year we got it afloat, and then bad weather came on, and we sunk it near the pier, and destroyed it; then the next year I built another at the dock-yard; I had leave from the Admiralty to build it there.

You built it by the aid of the Government?—Yes.

What was the dimension of the caisson?—Thirty feet diameter, diminishing one foot in six.

Looking at this model, that is circular as it appears on the plan?—Yes.

Do you mean the gentlemen to understand that all the caissons are to be upon that principle?—Yes, they might be built in the dock-yard, made complete, and floated out; there would be nothing but to turn the cock and let the air out, and they would sink immediately.

You would make them of cast-iron?—Yes.

Do you do that by the same means, by chambers?—Yes, if I was going to build them in hundred feet lengths, I should make only two chambers.

(*Sir Howard Douglas.*) What do you propose on the Goodwin?—The base was 30 feet wide, diminishing one foot in six; 42 feet high, 12 feet above high-wate mark.

Did you ballast the lower part of your caisson with concrete?—No.

When it broke away, was there any concrete in it?—No, it had not quite got down to the bottom, it did not go down six inches for two months.

Did you find the lower part of the 28 feet very hard?—Yes, hard black sand, the whole of the sand is very hard black sand.

It went a certain way itself, did it not?—By the ebb and flow of the tide, if the wind blew very strong it would cant it over in this way (*showing it*).

What kind of progress did you make in bringing it down?—It went down of itself, and went right down to the bottom.

There was no excavation?—No, none at all.

It went 28 feet down by its own weight?—Yes, there was 12 feet of water, and the caissoon was 42 feet high.

You mean that there was 12 feet in the water, and 16 feet in the sand?—Yes.

Did it go down 16 feet into the sand by its own gravity?—Yes; I never put a shovel into it, every time the tide came up, it threw up the sand underneath.

Had you water inside?—Yes, when the sand was up to the first chamber we went down to excavate it; then when it came to high-water mark again, the sand was all gone; then it canted over sideways.

Did the high tide cover your caisson altogether?—Yes, we had to put six more plates on it when we took it out, when it was just 42 feet; then when we got it out, it was a very fine calm night, we worked at it all night, and had fixed a tier of plates on; then when it came to blow a little strong to the westward, that caused the sea to pour in over the caisson, and it sunk so fast that the water rolled over and struck against those plates; the tide rose two feet higher that morning, and the pressure of the water broke off those plates. That was the pressure of the water.

Should you have no difficulty in dealing with your caissons in eight fathom water?—No, I think there would be no difficulty if they were made complete in the dock and floated out; they can be made to any extent, and of course they could be so constructed that they will float according to the displacement of water.

(*Lieut.-Colonel Alderson.*) What water did your caisson draw when you took it to the sand?—Twelve feet exactly.

Your plan shows the section, and there is also an inner chamber of the same kind?—Yes.

Then there is a large outside cylinder a little conical, had you any inner chamber in its place?—This was all perfect.

You had some people on the chalk 28 feet below low water, had you any people at work below low water before your caisson gave way?—This only shows that it was to be carried out, the men were not there.

Were there men excavating below low water before it broke away?—No, we did not require to send men down, we worked on the sand at low water.

You never had an opportunity of testing the experiment by sending your men down to work at low water under those chambers?—No, we did not go down.

How did you find that the sand at 16 feet was hard black sand?—We could see it in the bottom of the chamber; the chamber would rest on the sand; it would sink, the same as a ship.

You never put pick or tool into the sand?—No, we did not require it.

You were understood to say, that you never had any persons below the level of low water?—Oh, yes, I had; and I have been down there myself working on the Sands. Sometimes, by opening the valve, the sand would come through into this cross chamber, but when I was on the beach we have pumped the air in here and gone down.

You had no means of steadying it?—No; the base being so large, steadied it.

But it went out of the upright?—Yes; at one time it was as much as four feet out of the upright.

How long after your caisson had attained its position was it that you met with the accident you have referred to?—These plates were destroyed the next morning they were put in.

Was there any proof that it received an injury from a ship?—I know nothing more than from a letter I received. Mr. *William Bush.*

(*Chairman.*) Is there anything further that you wish to state?—I have nothing further to state; but if it makes no difference where the harbour is, I should be very happy to enter into any arrangement for the trial of my plan. I do not want the Government to be at a farthing expense. I will do it myself if they will allow me. 8th May, 1844.

What will you do?—I will carry out a caisson.

You mean an experimental caisson?—Yes; to show the effect.

You have already put down one as an experimental caisson, and that has been carried away?—Yes; but I would not attempt to build one, unless I have the dock-yard to build it and float it out.

Where would you wish to build it?—If it is to go into the Downs, I should like to build it at Sheerness. It would float out like a ship.

[*The Witness withdrew.*]

Adjourned till to-morrow at 12 o'clock.

Thursday, 9th May, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Sir *John Rennie,* examined. Sir *John Rennie.*

(*Chairman*). The Commissioners have before them a plan of yours for enclosing the small Downs. In the evidence you gave before the Committee on Shipwrecks, you stated, in answer to question 5966, that it will be four miles and a half in length, but in your Report to the Commissioners of Ramsgate Harbour, you say it will be five miles, will you have the goodness to explain how that is?—The fact is, that in any work constructed upon the Brake, the operation of accumulation, which I consider will be produced by the works if conducted in a judicious and proper manner, will be rather to raise and increase the shoal in a particular position; it may be a quarter of a mile, more or less, for it is difficult to state whether it will be five miles or four and a half, till I know specifically the whole extent of the operations intended to be carried on. It is not like constructing a mole out in the open sea, where the whole work must be done entirely artificially; but here the object is to endeavour to make nature operate with us in conjunction with art, so that it is a very difficult thing to say in the first outset what would be the whole quantity which would be required to be done. I have given, in the Report to the directors of Ramsgate Harbour, an outside estimate, comprehending everything; but, I believe, provided the work be carried on, only a portion of it will be required.

Going to the greatest extent you contemplate under the circumstances you have stated, what would be the distance?—Five miles.

In answer to question 5967, in the same Report, you state the expense for four miles and a half to be from 1,250,000*l.* to 1,300,000*l.*, but in your Report to the Ramsgate Commissioners, you state it at 3,280,000*l.*, or, if reduced to a work of one mile, 850,000*l.*, some explanation appears necessary in reference to the great difference between the two first sums?—My answer to the Shipwreck Committee was intended to convey the idea that 1,200,000 to 1,300,000 would make a good harbour; and in the estimate I made, which is contained in my Report to the trustees of Ramsgate Harbour, it is stated that, provided the whole of the sand of which the Brake is composed should be scoured away, and it should be necessary to replace it with an artificial breakwater, the entire cost would be, as I have stated in my Report, 3,280,000*l.*; but, as I have stated also in that Report, that there is no doubt, in my opinion, that nature will do a large portion of the work itself, I am satisfied that a very considerably less sum than that will only be necessary; but I have put it as an extreme case; and I must refer to that Report as to what I have said with regard to the particular mode of constructing this work. As it will be a work of accumulation, produced by artificial means to a certain extent, it is very difficult precisely to state the amount; but I am quite satisfied that the sum I stated in my evidence before the Shipwreck Committee, namely, 1,250,000*l.*, would be ample to make a very efficient harbour there.

You state that the shoal in its movement rather extends outwards than otherwise?—Yes, at the end.

The fact of the case, as reported by Captain Bullock, shows otherwise, that it has not extended outwards?—I think the old charts, on which persons must go in judging of the existence and form of these shoals, have been in general so very vague that it is very difficult to state where any alteration has taken place in a great extent. I think the bearings may not have been taken in that correct and accurate manner in which they are now taken; and, consequently, that a great allowance must be made as to these measurements; but if you refer to the cause which has produced these shoals, they must be taken, not merely from the position of the shoal itself, but with reference to the adjoining headlands: and I doubt whether it can historically be shown that such an alteration has taken place in reference to those headlands, I mean the North and South Forelands, as to produce such an extraordinary change of the Brake as we have heard of from Captain Bullock.

That of course must be matter of conjecture?—To a certain extent it must be matter of conjecture, but I think we must look to the natural causes. If you find that the

Sir *John Rennie.*

9th May, 1844.

projection at the North and South Forelands has been reduced very materially in a certain number of years, and that they are brought nearer to a line with the outer portion of the Brake, that is proof of the fact; but it is impossible to lay it down exactly without reference to those historical facts. There may also be other causes in operation which may require explanation.

Those you have embraced very much in your Report?—Yes.

Supposing the work to be carried to the greatest extent, you state that your estimate amounts to 3,280,000*l.*, and if reduced by the circumstances to which you have referred, to 1,125,000*l.*; and that if the distance is confined to one mile, it would be 850,000*l.*?—I should like, before I give a specific estimate for any minor portion, to have a little time to consider the matter; and I would rather give my views on paper, if I may be allowed; for in writing a Report, like that before the Commissioners, the great object was to apply principles, and to show the extreme expense which would be incurred; but if the measure is to be modified in any way, I should like to reconsider that, and state it in writing.

What would be the limitation to the work if the expense is to be only 1,300,000*l.*?—I will answer that hereafter, in a paper I will deliver in; but I beg to be permitted to read one passage from my Report to the trustees of Ramsgate Harbour, which may serve to illustrate this: "With regard to the probable expense of constructing a work of the magnitude above recommended for the Brake, thiswill in a great measure depend upon the extent to which it is carried. If it be made of sufficient magnitude to cover the whole space from the North to the South Buoy (which is probably far more than is necessary), where there are six fathoms at low water, it would require to be nearly five miles long, the cost of constructing which would be very considerable; but if it be correct, as stated in the former part of this Report, that this bank has been formed by the deposit occasioned by an eddy, it is very probable that in making proper works to increase the eddy the deposit might be made to accumulate to such an ex ent as to materially reduce the quantity of artificial work to be performed; but even supposing that the whole of the sand forming the Brake should be removed by the current, which is extremely improbable, because any works placed upon it would certainly have the tendency to increase the eddy, and consequently the deposit, rather than diminish it, the cost of replacing the whole by an artificial breakwater would not exceed 3,280,000*l.*; but as probably a length of about 1500 yards or a mile would suffice, at least for some time, the cost of this would be 820,000*l.*" Therefore, with regard to that, I have not represented that I consider those figures as certain; and before I speak definitively as to the cost, I should wish to have an opportunity of reconsidering it; and if any certain length to which it might be considered advisable to carry the work is stated, I will give a specific answer to that, and it will be a question whether, in constructing the work, it will be desirable to carry it above high water, or to keep it at the level of half-tide.

If only one mile is done at a cost of 820,000*l.*, what shelter will it give, or what protection from the south wind and the heavy sea brought in from that quarter?—If it is proposed only to make a mile, I should give a different design altogether. If you make it two miles, then I should take another position, and so on.

You would not start from the north in that case?—No, I should make it altogether different.

You think that one mile would give a considerable protection to the shipping?—Yes, if properly placed; but if one mile only were done, a different form must be adopted, in order to give protection from a particular quarter.

Supposing the work to be carried to the full extent you contemplate, it appears by the plan on the table that it would be open to a heavy sea running in at the mouth of the anchorage?—I do not consider that the precise plan laid down here is altogether settled. If the work were to be carried out, it would require to be modified according to the particular accumulation of the shoal; it might be so arranged as to give the desired protection when the work was carried into effect. As to this particular mode of converting a shoal into a breakwater, an idea which is rather novel, it must be worked according to the particular mode in which the shoal increases. In carrying such a work into effect, the object would be to keep as deep a channel within as I could; and the scour through it would deepen rather than diminish it. It would be equally an object to give protection to the shipping from the dangerous quarter; and in working these two together, a little modification would be required if the current might be rather inconvenient—the shoal might be increased on one side and diminished on the other—until the desired object might be obtained. In working this, very much will depend upon the skill and judgment with which it is done, and the mode; and before I could give a specific answer to that, I should like to reconsider all those points, and to know the quantity of protection required.

Any work to obtain this protection would occasion an expense to be added probably to the estimate?—No; because I consider that the estimate I have given will be ample to give all the protection required. I repeat again, that in forming that estimate I have allowed for any alteration that might be desired; it would not effect the principle.

What is the nature of the work you propose?—As I have stated in my Report, the exterior of the work might be constructed of hard rubble-stone, the interior of masses of chalk and shingle, or timber or iron might be used with advantage. But, as I stated before in reply to a similar question, I will give in writing, in more detail, the principle on which the work might be carried out, if the Commissioners require it.

It appears, in answer to question 5959, in the Report of the Committee on Ship-

Sir *John Rennie.*

9th May, 1844.

wrecks, that you found no chalk bottom in boring the Brake at the depth of 27 feet; do you, after that, feel a confidence in building on such a bed of sand?—Perfectly; the same cause which has existed continues now, that is, the shoal has been produced by an eddy, and so long as you increase that eddy the shoal must increase, and under those circumstances there will be no difficulty in constructing and in maintaining the works.

Are you aware of the great change in the position of the Brake Sand, it appearing from the chart received from the Admiralty that it has gone on bodily towards the shore to the distance of nearly half a mile?—This chart which I have adopted is Captain Bullock's. I have no doubt that the shoal is correctly laid down by Captain Bullock; but with regard to the alteration, I think there are no data to prove that, for I believe the old charts have been so incorrectly made, without regular data from which to measure, that they require to be supported by further evidence.

You only suppose that the old charts were inaccurate in laying down the Sand?—Yes. Then, again, I give my opinion upon the present state of the Brake, and the causes now existing to preserve that Brake and to keep the channel open. I take it upon the present state of things.

In consequence of this change the Brake Sand occupies a part of the space you intended for anchorage, would the remaining part be sufficiently spacious, and with a proper depth of water, for 300 sail of large merchant-ships?—I think it would.

There is a depth of water marked in your plan of 21 and 22 feet, in the inside of the anchorage, and as there is little, if any, shelter from the heavy sea which comes in from the south, do you think that depth of water would be sufficient for vessels drawing 18 feet, allowing for the pitching of the ship?—When once it has been determined to what extent the work on the Brake shall be carried out, there will be no difficulty in so designing the works as to give the desired protection over the depth of water before mentioned; and as the current between the Brake and the shore would certainly be rather increased than diminished, the consequent tendency of that would be to increase the depth of water rather than to diminish it, I have no doubt, considerably.

When you undertook to construct a work of this kind on the Brake Sand, did you contemplate that it would be a protection to ships of war?—I did.

As our large frigates in the present day draw 21 feet, and merchant-ships of the larger class not less, do you think a depth of water for ships of that magnitude, namely, 21 and 22 feet, being required, it would be necessary in that case to extend the works further to the southward?—We should get four and a half to five and six fathoms.

The getting into deeper water would probably be on an increased estimate of expense?—No; I contend that my original estimate will be ample to give that, and when I have time to reconsider the matter, and give an answer to these questions, and to detail the mode of carrying the work into effect, I hope it will appear to the Commissioners that I am right.

In answer to question 5978, you say the tide will be increased by putting artificial works, properly managed, on the Brake, and be likely to give an increase of two or three feet of depth to the anchorage, as it must carry away an immense quantity of mud or sand, where do you suppose that would be likely to deposit itself?—I think it will very likely go to form part of the work itself.

Is there no reason to fear that it will settle down in front or about Ramsgate Harbour, or tend to increase the shoals at the north end of the proposed anchorage?—I should doubt that very much.

It is the anticipation of this increased depth which makes you suppose the anchorage will be sufficient for the large ships?—It is not merely that anticipation, but by extending the works to the southward I should get the depth required.

Taking the depth as it really appears by the chart, you admit it is not sufficient for ships of that magnitude?—Certainly it is not along the whole line; but by extending it to the southward, sufficient depth would be obtained.

If there is an increased tide, by reason of this work, where it is already known to run strong, will not that tend to make the ships ride very hard upon this anchorage in a heavy gale from the southward, where they would feel the weight of the sea?—I should say not, because by placing the work in a proper direction there would be ample protection for the vessels from the southward, and deep water to enable them to ride in safety.

In point of fact, do you conceive the Brake affords shelter from the heavy distressing sea flowing in from the Downs?—The work might be made so that the shipping would be protected if the works were carried into effect properly.

Is it known to you that one of the most intelligent members of the Trinity Board, the late Captain Drew, has left a record of his opinion against the constructing the proposed work on the Brake?—That is not the impression I have of Captain Drew's opinion. The former Commission, of which he formed one of the members, allude to the Brake only as being a work too extensive to be taken up. They did not at all enter into the question as to the merits of the plan, but merely as to its magnitude and expense; and Captain Drew, in a conversation I had with him upon the subject, did not appear to me to have decided against it.

You are, no doubt, sufficiently acquainted with nautical matters to know that bringing up a short-handed merchant-ship to an anchorage, in a gale of wind, is a difficult operation. Has it occurred to you that the increased rate of tide you speak of would render the operation more difficult and hazardous?—I think not, for she would bring up in it with great facility; the moment she came within the protection of the works, she would

Sir *John Rennie.*

9th May, 1844.

come to an anchor with great facility; I apprehend there would be plenty of well-protected room for her to bring up and come to an anchor.

It is through the anchorage you speak of the increased current that will be produced by narrowing the channel?—Yes; but still there would be sufficient protected space to bring up on; I do not think that would materially affect her.

It appears by the chart that the north entrance is very shoal, in some places only 11 or 12 feet. Supposing a ship to break adrift in a gale of wind from the southward and no escape out of the passage, must not she go ashore on some of the sand-banks?—The bottom is chalk, and it might be deepened by dredging to any reasonable depth.

Would not a ship breaking adrift when lying in the Downs be able to save herself by running into Ramsgate, or elsewhere?—Yes, she might.

Do you think the anchorage within the Brake can properly be called a harbour of refuge?—I think it might, and a most important one.

In answer to question 5960, in alluding to Trinity Bay, you say "it is a very difficult thing to predict precisely what effect your operations may have, not only on the Sand itself, but on the immediate neighbourhood;" does not the same doubt apply equally to the altered current by means of the work on the Brake?—Certainly not; because, in the one case, it is on so large a scale that it might be difficult to manage; but the work on the Brake I consider a very manageable subject, and with proper management I should not apprehend any danger of the kind alluded to.

How long will you take to execute the work, supposing it to be carried to the extent of five miles?—That is a question I should like to have time to consider before I answer it. It will depend in some measure upon the rate at which the shoal accumulates; as the artificial works of this should take place rapidly, a very few years would suffice.

In calculating the time it would take, what number of days would you allow, in the course of the year, for the interruption of your work?—I should think about one-third of the year must be allowed.

In the construction of the Plymouth Breakwater, the average of six years give 133 days of work, with the advantage of a harbour close at hand for the stone operations, would not that be too high an average to assume for working on the Brake?—I think not at all; for there are, in winter, many days on which they could work. In fact, by this very operation the sand would be set working for us; and I should rather like stormy weather, for by stirring up the sand below, it would enable it to work more efficiently.

You expect the sand will be forced up?—Yes. I look upon the stormy weather to be one of the most efficient means for performing the work itself; the artificial works being constructed during the summer, the remainder would go on all the year round.

Where would the vessels employed in bringing materials to the spot find shelter?—In Ramsgate Harbour; there is plenty of room for almost as many vessels as we should want.

From whence do you propose to get the hard rubble-stone?—That is a question I should like to take time to consider. All the details of the estimates, and the mode of construction, I should wish further to consider. It is perhaps sufficient, at present, to say that there are several places where it might be got; and the estimates are ample if the principle of the work be acceded to: I could soon prepare all the details.

Will not the vessels attending on your work be under a greater disadvantage than those at Plymouth, in consequence of Ramsgate being a tide harbour?—To a certain extent, that may be the case; but then as, by means of these works, there would not be the same assistance required, I think there would be much more advantage in favour of the work proceeding than in Plymouth.

You seem, in your Report to the trustees of Ramsgate Harbour, to infer that, as 38,257 sail have gone into Ramsgate in 30 years, that is evidence of the want of another harbour close to it, as you say there is no doubt that many vessels, in certain months, passed on for want of such a port; may this fact not tend to show that, if 1200 or 1400 sail enter Ramsgate, they are as many as have occasion to do so?—I think, if they had more accommodation, more would go in; for at present, in consequence of there not being sufficient accommodation in Ramsgate, particularly for large ships, they are obliged to lie in the Downs. For the purpose of providing for their accommodation, a very efficient work might be added to Ramsgate Harbour by making a new basin to the westward, having the entrance near the present new west pier-head, to have six feet at low water, which is the depth at the entrance; and by that means they could always take in a sufficient number of large vessels to be ready for sea, whenever the weather was favourable. That would be an important addition, and it would add materially to the effect of Ramsgate Harbour. Another defect is, that the surface of the inner basin or scouring reservoir, being only 11 acres, is too small to allow the effect of the sluices a sufficient time to operate, for the first effect is lost in 10 or 15 minutes after the doors are opened; whereas, if there was another basin to the westward of the present, of the capacity and depth I allude to for large ships, the scouring power will be doubled, and it would be a very valuable addition to Ramsgate Harbour; vessels of 18 or 20 feet might then come in, and always lie afloat. I do not know any place where such a work would be so valuable as that. It is an extremely difficult thing, on a coast like this, to get a harbour six feet deep at low water in spring-tides, with piers attached to the shore. Ramsgate has that at present, very nearly; and it might very easily be made so; and, with the addition of a dock of the same depth at low water as the entrance, large ships might come in and be kept afloat, and a very great public advantage would be the consequence.

Sir *John Rennie.*

9th May, 1844.

(*Admiral Dundas.*) If you were desired to fix on a position, between the North Foreland and Portsmouth, for a harbour suitable for the following objects, namely, a harbour of refuge for the trade of the country from storms, a refuge from the pursuit of the enemy, and a proper place for a squadron of frigates and steamers, to afford protection to the trade of the country, and to carry on offensive and defensive operations, what place would you recommend as most favourable for all those objects?—That is a question I must take time to consider, as my instructions, in making this report, were confined specifically between the North and the South Foreland; indeed, more particularly to the Brake, and I had no opportunity of going beyond that.

Do you think the anchorage within the Brake would be applicable to those purposes?—Certainly, for the mercantile navy, and for men-of-war too; but I am not prepared to say that it is decidedly the best that might be made, without further consideration. For the mercantile navy, nothing could be more appropriate. It strikes me that, if you take circumstances as they at present exist, and recollecting that the wind blows from the southward and westward for nine months out of the twelve, with which no vessels can go down Channel, and if it is strong they cannot keep the sea, and cannot get round the South Foreland, but are obliged to come to anchor in the Downs, and as (when the wind is easterly) they cannot get up the Channel, and the great bulk of the trade is from London,—taking all these circumstances into consideration, there is no place more applicable to the purpose than the Downs or the Brake in this quarter.

If you were not limited in the choice of a place for constructing a harbour, would you deem it expedient to spend the money in making a harbour within two miles of one already capable of giving shelter to 1500 ships in the course of the year?—Alluding to Ramsgate Harbour, I think Ramsgate Harbour, not being a low-water harbour, it is very desirable to have a low-water harbour as near as possible to it; for, in that case there would be an outer roadstead, so that in the event of any bad weather they could easily go into this harbour for the purpose of shelter; whereas, if the work was constructed without some harbour like Ramsgate opposite, I think it should be constructed in a different way For repairs, and so on, if necessary, I think Ramsgate would have an additional recommendation; and, supposing it fit for the mercantile navy, it is only necessary to make it still more complete by an outer harbour, when all classes of vessels could run in at low water.

Should you prefer the proposed harbour within the Brake to a harbour constructed at Dover or at Dungeness?—A harbour at Dover is an extremely difficult subject. I have not been able to devote sufficient time to it, and that has never been officially brought before my notice, calling upon me to give an opinion upon it. There are very great difficulties in making a proper low-water harbour at Dover. I am not prepared, at this moment, to say that it cannot be done; but there are difficulties—first, in making it, and then in maintaining it; and before I could definitively commit myself, as to Dover, I should wish to have further time.

What do you say as to Dungeness?—Provided you do not attach your work to the shore, a very good harbour might be made there. Dungeness is a very peculiar position; and before you could attempt or think of constructing any work, either there or in the neighbourhood, you must ascertain the formation of Dungeness. It is a very curious geological phenomenon. You have a very low point or cape projecting many miles to the sea, between two very high forelands; Beachy Head on the one side, and the South Foreland on the other. The particular causes which have produced that in the first instance, and the causes still in operation to increase that, should be thoroughly investigated before any work was attempted there. I have my ideas (rather crude, perhaps,) upon that point; but when I answer the questions which have been proposed to me in detail, I may be able to state something more definite upon it if you require it.

When you surveyed the Brake, it was under the idea of a harbour of refuge being provided opposite to Ramsgate Harbour?—No; my instructions were to consider whether an efficient asylum harbour could be made on the Brake.

What depth is there in the North Channel at spring-tides?—The depths are stated in my Report. Taking it from the chart, I should say from 12 to 13 feet.

Without deepening the north passage into the intended harbour within the Brake, a ship could not enter at all times of the tide?—That depends upon her draught. Certainly vessels of any size could not come in at low water unless the entrance was deepened.

No vessel drawing more than 10 feet?—No, no vessel drawing more than 10 to 11 feet, certainly. In reference to that answer, I should wish to add that, by not commencing the works so soon, that is, commencing them to the southward, you would have a greater depth.

But still it would require deepening to admit ships of all sizes?—Not provided you carried the work sufficiently southward.

That is not according to this plan?—No, it would require a different place.

In case of hostilities, it would be necessary to have steamers of war ready at some prominent parts of the coast from which they could get out at all times of the wind and tide; do you consider the Brake Harbour, if made, a place likely to suit for that purpose?—I think the Brake might be made a very convenient place for that purpose; but, as I have already stated, my observations in planning this work upon the Brake were confined to that, and did not go beyond it, therefore I am not prepared to state whether there were other places more to the westward that would be better.

When you proposed that harbour, it was with reference to a harbour for merchant-

Sir *John Rennie.*

9th May, 1844.

ships?—My view was not confined to that, but the principal object suggested to me was a mercantile refuge harbour.

Nothing was said about a time of war?—No; but by extending the works southward, you might get any depth required.

Have the goodness to explain how carrying the proposed works further to the southward would increase the depth of water in the northern channels?—It would require a different arrangement altogether. If an allusion is made to this particular plan, there would be great difficulty in doing it; a different position altogether must be taken, and the work must be designed *de novo*.

It has been explained to you that the proposed harbour of refuge is to be accessible to merchant-vessels of the largest size, and to men-of-war steamers; will the place you propose to erect on the Brake afford the means of anchorage in the Little Downs?—I conceive it will.

For merchant-ships of the largest dimensions, and ships of war; as the entrance to the north of that harbour appears to have only 9 or 10 feet water, how do you propose to make a channel?—If you desire to have both entrances, you might deepen the northern entrance 4 or 5 feet by dredging; 18 feet at low water is hardly sufficient for those large vessels, but in the southern entrance you might have any depth you required.

There appears, at present, no navigable channel for large vessels, or vessels even of a moderate tonnage, at all times of the tide, to the northward and eastward of the proposed harbour inside the Brake; are you of opinion that such a channel could be formed and kept clear, and, if so, at what expense, and for what time?—To dredge 21 feet would be rather an expensive operation, but it is not an impracticable operation. With respect to the time for doing it, I wish for further time for answering that.

With reference to the changes which appear to have taken place in the position of the Brake-sand, do you consider it perfectly safe to found upon it either works for protection against the enemy or protection against storms?—I have no doubt it might be done safely. There is a work I should recommend the Commissioners to see, I have not seen it myself, but I have heard of it, at the mouth of a harbour on the coast of Holland, something similar, I understand, to that proposed here. It is a work of a very extensive nature, a work performed by means of timber and stone, and assisted by the operation of nature, so as to bring the current to the mouth of the Zuyder-zee, in front of the great canal which goes to Amsterdam, and forms a very important breakwater besides. I have heard of the work, and I have frequently proposed to go and see it, and I think it is very well worth the while of the Commissioners to inquire about it.

Are you of opinion that such a harbour as you have described may not be constructed in Dover Roads?—I have not had sufficient experience of Dover to form an opinion upon it; it is a very difficult subject. On the one hand, there would be a greater chance of keeping it open by making the work isolated, that is, open at each end, unconnected with the shore. On the other hand, provided, as there is reason to believe, that the progress of the beach depends not only upon the effect of the current but upon the waves combined with the current; presuming that, if a detached breakwater were made in front of Dover Roads, the beach would become sheltered, and the same means of preserving a free drift of beach along the shore would not be preserved. Now, as this is a question rather speculative, I should not wish to give a positive opinion.

Are you aware of any difficulty to the construction of such a harbour as that described to you in Dover Roads?—A work might be constructed, no doubt, but then the difficulty of preserving the depth, after you have got it, is a question which I should wish to have more time to consider before I answere it.

From the knowledge you have of the relative positions of the anchorage inside the Brake Sand and the Dover Roads, are you of opinion that there is a greater chance of the harbour filling up in Dover Roads than inside the Brake Sand?—As I stated before, my views have been confined to the space between the North and South Foreland, and I should wish therefore to decline giving an opinion upon that at present.

(*Lt.-Col. Alderson.*) In speaking of the materials for constructing a breakwater, you stated that stone and chalk, and iron and timber, might be used with advantage?—Yes.

In forming this estimate of 820,000*l.* per mile, was there any iron or timber?—A combination of all together, a certain portion of iron and timber, and stone and chalk.

You have alluded to the difficulties of constructing a breakwater at Dover, are those engineering difficulties to which you allude?—The difficulties are both engineering and geological, the principal geological; the engineering difficulties may be removed by a sum of money. I do not mean to say a proper harbour may not be constructed at Dover, but before I give an opinion upon it, I should wish to have time to consider it, if the Commissioners wish me to turn my attention to it. In my Report I have alluded to the position of Dover as a good position. The fact is, I have begun to consider it, and have gone back to the early history of Dover Harbour. I have made a commencement in the time of Henry VIII., and have got some very curious documents from the Cottonian Manuscripts, with drawings of all the different changes connected with it; and the history is very curious. Originally, from the facts we have, there was little or no mud in Dover Harbour, it was simply a bay formed in the chalk strata, and a small river coming in there; the Dour discharged itself at times, when it could, into the Channel; but in consequence of the prevalence of southerly and westerly winds, and the beach driving from the westward, a shingle bank was formed in front of the mouth of the river, so that the river, before it could get to the sea, was obliged to expand itself into a large lake; when

Sir *John Rennie.*

9th May, 1844.

this lake got sufficiently full from the waters of the interior, and when the winds were not so strong without, it burst through its barrier, and forced itself into the sea. Thus the the shutting and opening of this basin soon occasioned, on the one side by the winds and waves from without, and on the other by the antagonist force of the waters from within, and the basin formed what is called Dover Harbour. Strangers looking at a position of that kind supposed that nothing more was requisite than to open the channel, and to confine it by works of art to preserve a proper harbour, but in proportion as those works were constructed the beach was increased, and the mud accumulated inside, and from hence has been the advance and receding in Dover Harbour.

(*Lt.-Col. Colquhoun.*) In your evidence you have referred to the possibility of a work on the Goodwin, what is your opinion upon that?—A work may be formed, but it would be on so great a scale, that it would require so much time to determine on with accuracy that I am hardly prepared to give an answer at the present moment.

Do you think a work of small extent could be formed by way of experiment?—If you begin with the Goodwin, and alter the form of it by the works, some parts would fill up and others deepen, it would extend itself materially in different ways.

Apart from the consideration of affording protection to shipping, do you suppose that the work you propose could be used for the erection of a military work upon it?—I do not see why it should not.

[*The Witness withdrew.*]

Capt. *James Vetch,* R.E.

Captain *James Vetch*, R.E., examined.

(*Chairman.*) You are understood to have a plan for giving stability to sands, and thereby converting shifting sand into a shelter for any neighbouring anchorage?—Yes.

Will you have the goodness to give the Commissioners some explanation of your mode of effecting this object?—I believe the clearest way of explaining it will be to read an extract from my Memoir on the subject:—"The water of waves in approaching a shelving shore or sandbank obtains a progressive and accelerated motion against the shore, so that when the waves break they are enabled to carry up and deposit at the top of the inclined plane the coarser materials with which they are charged, but they bring down again the very fine sand and mud, these last being suspensible in agitated water from their small bulk compared to their surface.

"The action of waves, therefore, on a flat and low coast composed of loose and shifting materials, is to heap up all the coarser materials on the shore, or line of sustention; but a sandbank covered at high water presents no line of sustention to materials thrown up from the weather side, and these are consequently either carried off entirely, or swept over to the lee side, to be brought back again or shifted about by every change of wind; and the surface of a sandbank, therefore, not only is unable to sustain any accumulation of matter by storms, as the shore can, but is vulnerable on all sides. What then is clearly wanting to give storms and waves a constructive action on sandbanks, instead of the contrary, is to provide an axis or line of sustention, which work, for distinction's sake, may be called a spinal embankment, as enabling a sunken shoal, on that nucleus, to become an island, and also to distinguish it as a mere axis of accumulation, from those embankments, intended to surround or inclose a given space. Having drawn attention to the general conditions of sandbanks, the subject of the Goodwin Sands may now be proceeded upon in detail, and the measures proposed for converting them to a more useful account may now be described. To meet the condition of the Goodwin Sands, in constructing the spinal embankment, it is proposed to use iron rods, in a position nearly vertical, penetrating $7\frac{1}{2}$ feet into the sands, and rising $7\frac{1}{2}$ feet above their surface; the upright rods to be about one foot apart, and arranged in square frames of 12 feet each side; and these squares complete (called iron gabions for facility of description) will each contain 48 iron rods on a space of 12 feet square, penetrating the sand $7\frac{1}{2}$ feet; and, considering what has been stated of the tenacity or closeness of the sands at that depth, it may safely be allowed that so great a number of prongs will give the gabion all the strength that can be required against any lateral force applied above the level of the sands; and, so far from seeking to go deeper for a foundation, it might be better to employ means to prevent any further settlement of the gabions. The iron gabion being fixed, and the rods inserted in the sand to the depth stated, it is next proposed to floor the interior space with hurdles, and on these to line the gabion with one row of fascines firmly fastened to the iron rods; and this first stage of the structure to remain without further addition until the action of the sea has heaped up the sand, externally and internally, to the top of the fascines, when a second floor of hurdles and second row of fascines will be introduced, and the operations continued until the gabion is filled. The gabions now described form but the first tier in the structure; and when the interior and exterior surface has become elevated seven feet, a second tier of gabions is to be keyed on to the first, and these last treated as the first. In the foregoing manner the author merely attempts to raise a barrier one foot high at a time, and composed of materials not offering a solid resistance to the waves, but calculated to receive and retain the sand on either side as thrown up. It will be obvious that, on such a surface as that of the Goodwin Sands, and where we cannot safely plant a heavy structure or acquire a solid foundation, we must endeavour to supply these deficiencies by embracing and holding on by as broad a surface as can conveniently and economically be attempted; and, with this principle in view, it is

Capt. *James Vetch*, R.E.

9th May, 1844.

proposed (on the line of spinal embankment) to lay down two parallel rows of gabions, 36 feet apart, bonded and tied together with cross rows at every 36 feet, by which means a base, 60 feet wide, would be procured for the spinal embankment; and, by the numerous cells of which it is composed, every facility would be offered for the accumulation and retention of sand, &c.; an object which would be still further attained by throwing out ribs from the spine, at suitable points, to intercept the passing sedimentary materials; and these ribs, embracing the sand to a still greater extent of surface, would increase the stability of the spine."

Looking at the cross section, is the whole of this space supposed to be filled with fascines?—No. There are four continuous parallel rows of iron rods lined with fascines one foot in thickness each, and the intervals between these parallel walls are supposed to be filled up with drifted sand.

So that, when this is completed, it will become a kind of solid body, composed of sand, iron, and fascines and hurdles?—Yes.

It is a wall, composed of iron rods and fascines and hurdles, 12 feet in thickness on each side, at the distance of 36 feet in the clear, with cross walls of the same material, leaving, therefore, a large square of 36 feet, which you suppose will be filled by the accumulation of sand?—Yes. I should prefer to use a quantity of seaweed between the layers of hurdles, if it could be procured cheap enough. I have seen some quite sound which has been laid down for 40 years, and if it could be got cheap enough, I have no doubt it would accumulate the sand more than anything else.

What do they use in Holland?—I understand seaweed is extensively used. In Wexford Harbour the seaweed has been much applied for embankments.

In that way you propose enclosing a large quantity of the Goodwin Sand; for what purpose?—For the purpose of preventing currents passing over the surface of the sands, either laterally or longitudinally; the great danger to shipping is from the indraught by the lateral passage of currents across. Whenever two channels are presented to a stream, one much larger and deeper than the other, the level of the two streams will vary at different times of the tide, and then there will be a current, from the higher to the lower, across any intervening bank as soon as the tide overflows it and establishes a connexion.

The object is to prevent the passage of currents across the Goodwin Sands?—I believe the moveability of those sand-banks arises from the immense surface over which the tides and waves now pass; that if they are prevented passing over the surface the effect of carrying away the material of which the bank is composed would cease; and I believe, from all I have been able to ascertain, the bank has increased in height, and would increase still further but for the great friction and agitation between the level of high and low-water marks.

So that, by carrying a screen or screens across the Goodwin Sands, which you propose, an accumulation of sand would take place on both sides of them?—On the weather side I believe it would be thrown up, and on the lee side it would be deposited.

Supposing the Goodwin was converted into an island by your plan, that would prevent the tide spreading over a surface of about 8000 acres?—Yes, about that quantity.

And force it into the Channel between the Goodwin Island, as it may be called, and the coast of Kent?—Yes; a small portion of it.

What increased velocity of the tide do you suppose this would occasion?—It would be difficult to offer any very definite opinion upon that point. There is no doubt an increase would take place; but, from the great width of the Channel between the French and the English coast, it would be difficult for a mathematician to give a definite answer of the small increase due to the inner channel, the velocity would not, I consider, be increased above four per cent. on the whole body of water passing between the Goodwin Sands and the Kentish shore.

If this plan should be carried into effect, do you contemplate a harbour on the Goodwin?—No; the conversion of the Goodwin Sand into an island would merely afford shelter on the lee side, and would make the Great Downs a more sheltered anchorage; and the sands would cease to be dangerous to shipping.

Supposing in war a fleet of large ships were called to act in the neighbourhood of the Downs for hostile operations, and it was considered necessary to anchor within the Downs, would not the increased rate of tide be felt very seriously to their disadvantage when blowing a gale of wind from the south, and a heavy sea?—I should not apprehend that the increase of the current would be so great as to create the mischief of making the riding materially different.

You speak of the advantage of this increased tide in deepening the Gull Stream and removing some of the other shoals, as this will carry away an immense quantity of sand and mud, where will it be likely to deposit itself?—In the nearest tranquil place, particularly in Trinity Bay.

What other tranquil place would be the most likely?—I do not know of any other tranquil place near at hand.

Do you apprehend it would occasion any shoaling of the water at the mouth of the Thames?—I should apprehend it could have no effect in the estuary of the Thames.

Not in carrying away the sand towards the mouth of the Thames?—I conceive the drift of sand and mud is in an opposite direction. It appears to me that if that project were carried into effect, the sand-bank itself of the Goodwin would present a tranquil surface of deposition greater than any other that now exists; it presents an extent of 8000 acres for a deposit to take place on, for a depth of 12 or 15 feet, in places besides

Capt. *James Vetch*, R.E.

9th May, 1844.

Trinity Bay, which has now seven, eight, and nine fathoms of water, the surface of the Goodwin Sand itself and Trinity Bay would then afford ample room and facility for deposition for centuries.

When Trinity Bay fills up, it must seek some other place of repose?—Then I apprehend it would pass down Channel, to the Ridge and Varne banks, or north to the Falls, and the Kentish Knock.

On the flood-tide through the Gulls where would it be carried?—The last two hours of flood, I think, is nearly to the north.

On the tide going through the Gulls, where would the sand be likely to deposit?—If it went in that direction, a likely place would be along the north side of the Margate Sands; but the Gull Channel shoals to the northward, deepens to south, and the inference is against the matter travelling up hill.

Is it in connexion with the work on the Goodwin that you contemplate carrying on an embankment from Ramsgate across the Sandwich Flats?—It may be taken in connexion with the Goodwin Sands or not. I conceive that the embankment along the Sandwich Flats would have the means of accelerating the current between the Brake-bank and the shore, and clearing Ramsgate Road and the Small Downs.

Is there any object in this embankment except reclaiming a large quantity of land; has it any reference to better accommodation for the shipping?—I have no doubt, as far as I am able to form an opinion, that it would very much improve the Channel between the Kentish shore and the Brake-bank, and also that the discharge of the river Stour through Ramsgate Harbour would effect several beneficial objects.

As this embankment and the converting the Goodwin into an island must produce a great and extraordinary effect on the tides, can you, with any confidence, say what that effect would be?—I should merely expect that the channels would be cleaner and deeper, but what the increased rate of the current would be I could not venture to offer a definite opinion. I do not apprehend any material increase to the velocity of the tide streams from these works; but the streams being confined between elevated banks, a more direct and fixed channel will be obtained by them; and by the same works they will be preserved from being diverted and dissipated by cross currents and gales of wind, which last after a long continuance have been known to drift the margin of the Gulf Stream many miles.

Any mischief once done by altering the direction of the tides by works of so great and prominent a nature could not be easily remedied?—It appears to me that the mischief which is now doing arises from the instability of these banks, and that if they were rendered fixed and stable, the mischief which now exists would cease to exist.

(*Mr. Walker.*) Do you think it satisfactorily proved that the Goodwin Sand, at the depth of seven and a half feet, is so firm as to be almost impenetrable?—We have the evidence of Mr. Smeaton and Captain Hewett; and Captain Bullock has informed me that he had been able to penetrate only to seven feet; the spar he has erected in the bank has only sunk to the depth of seven feet in three years; and from all these circumstances at different places and by different observers, I am inclined to form an opinion that the general state of the bank is such as to offer a great resistance at that depth.

You found your proposition upon the authority of those different reports?—I have done so, but I must beg leave to explain, that if it should be found that the Sands are penetrable in places to a much greater depth, that would not affect the practicability of the scheme.

Do you think that the sand would be found to have the same denseness throughout so as to occasion the pressure of the gabions sinking some lower than the others?—In that case it would be very easy to have the perpendicular rods made of a greater length and to take a deeper bearing for the gabions.

As you ascertained any greater yielding of the sands, so you would act?—Yes.

(*Chairman.*) Suppose, as an experiment, Government were disposed to sanction a trial of your plan on some sand at a moderate expense, say about 3000*l.*, how many yards could you accomplish for that sum?—I have formed an estimate that it might be accomplished for about 24*l.* per lineal yard supposing the rods to penetrate seven feet and a half; the whole breadth is 60 feet.

Do you know of any sand which you could operate on for that sum in a situation, that if it answered it would be found a useful protection, for instance, the Smithwick bank off Burlington Bay?—The Smithwick bank is covered from two to four fathoms constantly with water, and therefore it would be a more expensive work than on a bank which was dry at low water.

Can you suggest any other sand where it might be tried?—The most easy bank near at hand is that at Margate, but how far that might be useful I must leave to naval gentlemen to judge. I should prefer some part of the Scroby Sand off Yarmouth.

If it is not carried out to its full extent the expense would be thrown away?—On the Scroby Sands the tide is only six feet, therefore, though constantly under water, the expense there would not be great for a trial.

Would you consider that making one of those squares of 60 feet would be a fair experiment for your scheme?—I should say not as an embankment on the Goodwin Sand.

Might it not be used as a foundation for a beacon?—I think that might be very usefully done, and is what has often occurred to me.

Suppose a sufficient quantity of work on your plan, say 60 feet square, to be put down for a beacon, what would be the probable expense?—On a rough calculation, I should say about 600*l.*

Capt. *James Vetch*, R.E.

9th May, 1844.

Since you have withdrawn from the Queen's service, have you occupied yourself as a civil engineer?—I have.

Have you been engaged in any harbour works?—I have had to examine and report on several harbours on the south and east of Ireland from Wexford round to Dungarvon.

Do you know anything of Dover?—I have paid some attention to that port. I was down there last October, and examined it, and formed some opinions respecting it.

Will you have the goodness to state the result of your observations?—Since I received notice yesterday afternoon, I have put together some remarks, and in reference to the Commissioner's Report in 1840, I observe, "The proposed harbour for Dover fronts the south-east with a pier about 2400 yards long, the average length and breadth of the harbour being 2000 yards by 1000, and therefore containing about 400 acres; the west wing projects about 330 yards from Cheeseman's Head, and the east wing projects seaward about 800 yards from the shore. The outer half of the proposed harbour has from four to six fathoms water, and the inner half shoals gradually from four fathoms to the beach. The bay of Dover is but a slight indent of the land, and in its natural state gives no shelter (in the deep-water anchorage) from any quarter except the north, that is directly from the shore. It is to be regretted that nature has not presented more facilities for the construction of a large harbour at Dover, as it is well situated for a War Port both for offence and defence; but to render it efficient for all purposes, every part of the construction must be executed by force or art at great labour and expense, (it is fairly taking the bull by the horns,) and when completed, no engineer could venture to say how long an anchorage enclosed by solid walls in that locality could remain open and available, as every analogy leads to the belief that such a piece of water rendered tranquil would readily fill up with sand and mud. The valley in which the town of Dover is situated by means of its brook discharges the surface water (from a space of about 20 square miles into the bay, together with the sullage and silt which the rains can bring down), and this, in the course of 12 months, must be considerable; this matter, held in suspension, passes through the Pent and present harbour, and is discharged from thence into an agitated sea; but if the bay be enclosed, and the agitation of the water be stilled, the matter brought down in suspension would no longer be diffused in an agitated sea, but would be deposited and retained in the proposed port. Again, it is notorious the tide currents along shore from Folkstone to Walmer Castle carry a great deal of silt constantly in suspension, as may readily be seen from the colour of the water; this silt or slime which is no doubt derived from the constant friction of the waves against the chalk cliffs and shores, is now carried to and fro along the coast; but in the event of enclosing Dover Bay, and producing still water there, the matter held in suspension would then speedily deposit, as occurred at Ramsgate Harbour as soon as the elbows of the piers were in progress of construction. At present the current of tide flows rapidly past Cheeseman's Head, but when the west wing of the proposed harbour is made to project 330 yards further into the stream, the current will be found more rapid, and be able to carry more matter in suspension, which will enter readily (in passing) through the mouth of the harbour and settle inside. It will be proper also to consider the effect of a rapid stream passing along the south front of the harbour as affecting the ingress and egress of vessels working through narrow entrances. I should beg particularly to call the attention of the Commission to the probability of a close harbour at Dover silting up. Mr. Smeaton found, in 1774, at Ramsgate, that 268,700 cubic yards had then been deposited in eight years, and that the accumulation was taking place at the rate of one-fifth of an inch per week. In 1841 Mr. Wm. Walker reports to the British Association that since the construction of the Breakwater at Plymouth, the depth of water over the works near the Citadel was diminishing from the accumulation of sand and mud, and was creating an anchorage where only rocks previously existed, and this it may be observed where there is a strong backwater. This may be an advantage if the process would cease when required. General Pasley found the interior of the Royal George silted up 29 feet, though externally there was little or no accumulation, and all these depositions simply arising from still water being procured. In our own time we have the example of Howth Harbour filling up to an enormous degree. In the evidence on the Shipwreck Committee I perceive a threshold or sill 12 feet high has been proposed to the entrance to the proposed harbour at Dover, for the purpose of preventing the shingle from entering by the sill, but the silt, being in suspension, would meet little obstruction in entering; and when once deposited inside, would be retained there. Another great difficulty at Dover is the quantity of shingle travelling along the shore, and which has repeatedly blocked up the entrance of the present harbour, a result, no doubt, aided by the removal of part of the pier at Cheeseman's Head; and what with the removal of a pier at the west horn of the bay, and the construction of one at the east horn, the frontagers have managed to gain a considerable slip of land at the cost of filling up the bay to the same extent; but if the pier at Cheeseman's Head was restored, and the Castle Jetty removed, the sea would claim its own again, and the entrance to the present harbour might be preserved. From the prevalence of south-westerly winds, and from the more violent storms coming from that quarter, the drift of the shingle at the end of a year is very considerable to the east; and a pier projecting from the shore near Cheeseman's Head must intercept the shingle in its north-easterly course, and prevent its entering the bay; but against such a pier the shingle will accumulate on the west side, and will then form a beach gradually stretching out to sea parallel to the pier until it arrives at the extremity, when it will commence to pass round and travel north-eastward, as before; the shingle forms a zone or belt from high-water mark to low, and I believe it only travels

Capt. *James Vetch*, R.E.

9th May, 1844.

on that zone; but against a projecting perpendicular pier it will, in process of time, create a zone or belt of its own, which will become a way for its future career eastward; at the same time it must be allowed that a peer 330 yards long, and projecting into water eight fathoms deep, would present a barrier to the drift of the shingle for many years; nevertheless to those who have observed the accumulation on the west side of Falkestone Harbour such danger must not be overlooked (as one of a very remote date), but that date will be brought very near at hand indeed if the face of the pier, instead of being nearly perpendicular, it presents a long slope to sea of four or five to one; in such a case the road for the shingle to travel upon would be already formed, and it might pass along in a comparatively short space of time. The great difficulty at Dover is to procure a scour of tide stream through the proposed harbour to prevent the deposition of mud and fine sand, and at the same sime to procure shelter and prevent the entrance of shingle coming in; these two circumstances requiring opposite remedies. Large openings or entrances to the harbour at the west and east ends might procure a stream over the anchorage ground, but the same would become more exposed, and the shingle would drift in; on the other hand, if there are no entrances at the west and the east wings of the harbour, the silt would settle in greater abundance, and between the two evils and conditions it is difficult to choose. The great question, if the harbour is resolved upon at Dover, is, by what kind of piers it should be enclosed; these must necessarily arise out of deep water, and if nearly perpendicular or at a steeper slope than 45°, there can be no breaking sea upon the pier, as at Plymouth Sound and Kingstown, and all damage from progressing and breaking waves may be avoided by such an arrangement; if, on the other hand, the slopes to seaward are four to one, as proposed, they will evidently bring on a destructive breaking sea without any necessity, and, as I have said before, such a disposition would form a road for the shingle to travel upon to the entrances of the harbour, and to block them up. The above are no matters of opinion, they are physical laws that have been acknowledged from the time of Sir Isaac Newton to the present, as shown by the writings of Playfair, Bremontier, Webster, Scott, Russell, and others. A wave will only break in shallow water; and if no shoal or shelving sea-wall is presented, there will be no breaker or progressive motion in the waters of the waves, the undulation of the sea will only rise and fall against a perpendicular or highly inclined wall and recoil, and vessels will rather be repelled than driven against such a pier; but the contrary will happen wherever there are breakers. Besides the two great evils of a long slope to seaward of the piers proposed for Dover Harbour, I should object to the deposit of such an immense quantity of loose material in a strong tide-way exposed to the winds and waves from three quarters of the compass, as, if such piers got breached, the dispersion of such a mass of loose stones would be a serious mischief. I think much credit is due to Mr. Cubitt for the ingenuity of the form of the caissons he proposes to lay down as the nucleus of his breakwater; and these caissons of a triangular section present a slope of 60° to the sea, and avoid all danger of creating breakers; but constructing them of a perishable material, he finds it necessary to protect them by long slopes of loose stones. I should therefore suggest that if these caissons were constructed of plates of malleable iron, fixed on cast-iron frames, and filled with the best concrete, they would effect the object in less time, at less cost, and the two great evils and the one great danger might be thus avoided. If a platform is requisite, two lines of such caissons may be laid down close together, and the interval filled with concrete. (See Diagram.) Mr. Cubitt's section of pier occupies a base of 372 feet wide with 40 feet of platform; that proposed to be substituted has 130 feet of base, and 62 feet platform. Some iron boats at the end of forty years have had no perceptible decay of the iron in their bottoms; and mooring-chains, taken up in Dublin Bay, after being forty years immersed, have been found uninjured. It is alleged that the iron boats are preserved by their motion through the water; but it is the same thing whether the surface of the iron passes through the water, or whether the water passes over the surface of the iron; and at Dover there will be no lack of agitation of the wave against the plates; and any internal decay or decomposition of the iron will form a strong cement to the concrete, investing it with the character of a rock, as has often been observed in analogous cases. Harbours may be divided into three classes: first, backwater harbours, as Portsmouth, Plymouth, &c.; second, channel harbours, as Spithead, the Motherbank; thirdly, close harbours, as Kingstown, Howth, &c.; the first are often incommoded with bars; the third are liable to silt up; and the second, having a thorough tide-way, are the best for all purposes." I beg to refer to one or two opinions in corroboration of my statement. Mr. Smeaton says, "A large mass of silt, partly composed of mud, but chiefly of very fine sand, has been brought into the harbour (Ramsgate) by the tide; this is the natural tendency of all harbours; a deposition and increase must take place unless there are powers either natural or artificial to produce a contrary effect." In respect of waves, in "The Transactions of the British Association," Mr. Scott Russell says, "That in an experiment it was observed that every wave broke exactly when its height above the antecedent hollow was equal to the depth of water. That waves of the sea, when they approach the shore or come into shallow water, become waves of translation, and obeying the laws already mentioned, always break when the depth of water is not greater than their height above the level."

Do you know Kingstown Harbour?—I have been there frequently.

Are you able to inform the Commissioners whether there is any silting up in that harbour?—I did not observe any at the time, but I think it is a harbour not so likely to silt up for a long time; there is no current passing in front of it and carrying matters in suspension along with it.

(*Admiral Dundas.*) If you were desired to fix on a position between the North Fore-

Capt. *James Vetch*, R.E.

9th May, 1844.

land and Portsmouth for a harbour suitable for the following objects, namely, a harbour of refuge for the trade of the country from storms, refuge from the pursuit of an enemy, and a proper place for a squadron of frigates and steamers to give protection to the trade, and carry on offensive and defensive operations, what place would you recommend as most favourable for all those objects?—I have come to a strong opinion that the Downs would be the most appropriate and most practicable locality for the formation of such a harbour.

The whole stretch of the Downs?—The space I have enclosed by breakwaters, &c., on the chart.

You are keeping in mind that it is intended for vessels of war carrying on operations, hostile or defensive, and giving protection to trade?—I see little difficulty in obtaining defences to protect the entrances to a harbour in that locality; the great recommendation to the Downs, I think, is, the possibility of acquiring a thorough tide-way through it, to keep the channel clean.

Do you mean if your work is carried on on the Goodwin?—I am alluding to works on the Brake and vicinity at present.

You give a warning against enclosing an anchoring-ground, in consequence of the possibility of its silting up, would not that be prevented by a flush-tide passing in and out of the two openings, and the bottom being kept in a constant state of disturbance by anchoring and weighing anchor?—If the harbour is provided with two openings, and there is a tide-way through those openings, I think it would prevent the deposition of silt.

(*Chairman.*) Does not the fact of there being little or no accumulation round the Royal George show that where there is an action of the tide the accumulation is not great?—Precisely so. The space outside was kept clear by a current, and the space inside, being tranquil, silted up.

In alluding, as you do, to Howth Harbour filling up, can you give any statement of the cause of that?—I observed Howth Harbour about four years ago, and have now particularly alluded to it as a prominent example of anchorages silting up when they are entirely enclosed and rendered quite tranquil, which promotes the deposition of mud and fine sand brought in by the tides. The deposition in Howth Harbour was excessive, and it is probable there are some powerful local causes which accelerate the process; but these I did not investigate.

Do you suppose that if a harbour were to be constructed in Dover Bay, the front of it running along in seven fathoms of water, and the west end not open, it would be liable to any accumulation of the shingle?—If the walls be perpendicular, I do not think there will be any danger in that case from the shingle.

Do you think that with two openings at Dover, and the ebb-tide running out at the bottom of it, if the bottom is kept in a constant state of disturbance, there will be much danger of the inconvenience of accumulation?—I should beg to say, that if one of the entrances fronted the west, and the other the east, there would be very little danger of the silt, if the tide current were permitted to pass through; but that I do not expect that the casting and weighing anchor, or raking up, would have much effect in removing the silt; it was tried at Ramsgate to stir up the mud by machinery, but it was found very ineffectual; without the aid of a current, the matter would deposit again in the same place.

The harbour at Howth has been abandoned almost since the harbour of Kingstown has been constructed?—It has nearly.

Do not you think that the filling up has been in a great measure in consequence of that?—I think it has very much answered the description Smeaton has given of Ramsgate Harbour, that without taking artificial means of procuring a back-water, Ramsgate will be filled up in the same manner; and that without some artificial means of back-water at Howth, that will be filled up.

You have said that you have a strong opinion as to the place at which you should prefer a harbour of refuge, be good enough to favour the Commissioners with your reasons for preferring the Downs for such a harbour, and in what part of the Downs you propose to erect it?—I refer to the Little Downs, as shown by the plan. In the first place, it is a good anchorage-ground; it is well situated for vessels bound to and from the river, when detained by contrary winds; and by some engineering improvements, I conceive the Channel might be greatly cleaned and deepened, and become much more valuable as a haven than it is at present.

You have said that the anchorage within the Brake, if it became deeper, would be very convenient for trade; but, taking it in its present state, is there sufficient depth of water for frigates and ships drawing 21 feet?—I think, without improvement, it would be hardly sufficient; but with the shelter I propose, the expanse of deep water would be ample.

Would not a harbour at Dover be as good as the Downs for vessels outward and homeward bound, supposing the anchorage as good?—The harbour at Dover appears the best for warlike purposes; and though I am hardly navigator enough to speak to the facility of getting in and out at an entrance 700 feet wide, I have a strong impression that fleets of wind-bound merchant-men and convoys would find it very inconvenient as compared to a harbour at the Small Downs with an entrance one mile wide.

The question refers to its position?—I think the harbour at Dover is most convenient for ships-of-war.

(*Sir Howard Douglas.*) In answer to a former question, when you were asked which would be the best for hostile operations, offensive or defensive, you said the Downs; but you now say that, for war purposes, Dover would be the best?—I did not mean to say that it would be the best for warlike purposes, I understood for every purpose, including those,

of course. I would beg to explain, that in giving a preference to the Downs over Dover, I imagine we should secure a constant tidal stream through it, and the harbour would be preserved of such a depth, that at Dover no such tidal stream can be reckoned on; and that while the one was constantly open, the other would run a great chance of being silted up. Capt. *James Vetch*, R.E. 9th May, 1844.

If you keep it open for the tide to run through, the shingle would get in?—Yes; at Dover it would, and if it were shut up, silt would deposit; and it would be therefore a very precarious work to lay out money on.

Which, for military purposes, would be the best harbour for steamers to lie for the protection of the trade?—I should consider Dover.

Do you consider that a length of 60 feet of your work, which would be only one square, would afford a sufficient experiment?—If it was placed on some most prominent point, the apex of some of the little spots now left dry, it might be preserved from any swash-ways. It requires the selection of some spot which would appear to form the apex of a sort of hill, and the extreme south or north end would probably answer best if placed on the Goodwin.

(*Lt.-Col. Colquhoun.*) From what you know of Dover, do you think that any scouring operations can be brought into the proposed new harbour, to assist in keeping it from silting up?—I do not think there could be to a useful extent.

You do not think that water could be brought down by sluices, to assist the tide out?—The quantity of water brought down from the Pent now appears insufficient to keep the mouth clear. Any back-water would be too small to have any effect upon a harbour of 400 acres of surface.

If anything could be done to give greater activity to the water inside, would not that tend to preserve it from silting?—I do not think that any back-water could be procured to a sufficient amount.

(*Sir Henry Pelly.*) When you spoke of deepening the part within the Brake, did you mean the harbour part or the mere entrance?—The northern entrance. I believe there is considerable obstruction nearly opposite Ramsgate from certain chalk shoals, and I think by dredging channels through them a deep scour would take place through the opening, which would serve to keep the entrance and anchorage clean.

Are there many parts of the proposed harbour in which there are six fathoms of water?—About 170 acres near the main entrance.

The great thing is to get an outlet; you think that might be got by removing the impediments which now make the channel so shallow?—That is my opinion; I think a north entrance might be obtained by dredging and ploughing. The main entrance is a mile wide and from six to seven fathoms deep.

In your plan you appear to propose embanking the Sandwich Flats; would there be any difficulty in that?—I am of opinion that by embanking the Sandwich Flats, there would be sufficient gained to pay the expense of effecting it. The soil is so rich that I have seen it carted away as manure for the land near Pegwell.

(*Capt. Washington.*) With respect to Dover, supposing Mr. Cubitt's plan carried out at Dover, would it not be an improvement to turn the brook which flows into Dover Harbour to the westward of Cheeseman's Head?—That is a measure which might be useful to prevent the silt depositing, but I fear the shingle would soon close up the passage again.

You speak of the fear of silt; do you think this more likely to silt up again with one central entrance or with two entrances?—The great thing to keep it clear of silt would be a western and eastern entrance; but in that case, a large western opening would let in the shingle and expose the anchorage.

(*Mr Walker.*) In speaking of Dover Harbour and its back-water, do you refer to it as it now is, or before the late improvements were made?—The proposed harbour will occupy about 400 acres, and I do not see the possibility of constructing any scouring basin of a sufficient size to effect that, without an immense expense. If the whole pent and outer harbour were now made into a scouring basin, and the gates removed to the entrance of the present harbour, I do not think even that quantity of water would be sufficient to make much impression.

You say you have not the means of forming a back-water?—No; the proposed harbour is backed by buildings and high grounds so much that it cannot be done on an effective scale.

Is there any possibility of stirring it up from the bottom by harrows, and so on, so as to carry it off?—I fear not to an important extent.

[*The Witness withdrew.*]

Adjourned till to-morrow, at 12 o'clock.

Friday, 10th May, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Sir *Henry De la Beche*, examined. Sir *H. De la Beche.* 10th May, 1844.

(*Chairman.*) Are you acting as geologist in connexion with the Ordnance Survey?—I am director of the Ordnance Geological Survey of Great Britain.

As it is well known that the shingle on the southern coast of England generally travels from west to east, have the goodness to state what would be the effect of having a

Sir *H. De la Beche.*

10th May, 1844.

western entrance from the shore, disconnecting the breakwater, as in Plan No. 1, or in seven fathoms water, as in Plan No. 2, in front of Dover, or any place where a tide-harbour now exists?—The shingle would, in Plan No. 1, travel along the shore, as it now does, without any such breakwater. If it be a vertical wall in Plan No. 2, then the effect would be to accumulate the drifting of the beach between the shore and the point of wall A. precisely in the manner of any other spur-wall or jetty, the shingles falling into deeper water than the common line of low water, and there accumulating at a certain angle; consequently, the whole of that corner would tend to be filled up by the drifted shingle. After a sufficient accumulation had taken place to advance the bank of shingle, the next effect would be for the shingle to be forced on in the direction of A. B., and it would accumulate beneath the line of low water. The constant drift of shingle from the west, and the constant action of the breakers, would form an addition to the bank A. C.; so that eventually (but it would be a long time before that could happen) there would be a tendency to allow some shingle to come across, and to be gradually accumulated in that direction.

Can the deposition of small sand and silt be prevented in the construction of any harbour of refuge, by which a roadstead, which is now exposed to a strong current, is made comparatively still water?—I apprehend that the silt, or other small detritus, mechanically suspended in water by the motion of that water, or forced forwards on the bottom by the current, must be deposited in all situations where the necessary motion to keep it suspended, or the friction to propel it onwards ceases.

If these two openings, C. and B., are preserved in the centre and at the east end, A. being closed, would the tide be sufficient to carry off and prevent that deposition of silt and mud?—During heavy gales of wind the minor sediments at the bottom, in seven fathoms water, could scarcely avoid being stirred up by the action of the waves; and the water, with this sediment mechanically suspended in it, entering into the body of the harbour, the silt and mud would be deposited when the necessary motion for keeping them suspended should cease. I apprehend that channels only would be kept comparatively deep in the line of the current of the tides; but I should conceive that the accumulation would, under the conditions before me, be slow, provided the tidal waters be not usually much charged with detritus in mechanical suspension, or much silt and mud be not forced in, by friction on the bottom, at the flood tide.

Supposing that gradual slow accumulation to go on, if it is kept in a constant state of disturbance by anything like an iron harrow, or anything that may be invented for the purpose, do you think that would keep the harbour free from accumulation of mud?—To a great extent it would, provided the tidal currents had sufficient velocity to carry off the mud, silt, or sand thus caused to be mechanically suspended in the water. If this were not the case, the matters mechanically suspended for the time would again come to rest when the disturbing cause should cease.

You do not anticipate any great sedimentary deposit, during heavy gales of wind, in addition to the usual drift of detritus along the coast?—From observation I should say that from a depth of about 15 fathoms the water becomes discoloured by the admixture of detritus during heavy gales of wind. In all cases, anything like a harbour of this kind can be considered as nothing else than an artificial cove, and therefore it is but reasonable to expect that sedimentary deposits must take place from the usual causes.

You think that if the harbour is kept in a constant state of disturbance there is no danger of its being lost?—Although sedimentary matter would probably be deposited, still that sedimentary matter would to a great extent be removed by the process described, provided, as previously stated, the currents could carry it off.

(*Lt.-Col. Alderson.*) Are you of opinion that if a breakwater, with an exterior slope of four to one, or about 15 degrees, were constructed in front of Dover, the shingle would travel on as it does on the beach, and deposit itself on the slope between high and low-water mark, that breakwater being carried out in seven fathoms water, and thus find its way to the entrance of the harbour?—I should apprehend that upon any breakwater having a slope upon which shingle can rest, if such breakwater be connected with the land, shingle would travel upon it in like manner as it does in the front of rocky shores, where between the beach, properly so called, and low water, there are often sloping beds of rock. By rest, I mean where it can remain at rest notwithstanding the action of breakers. If the crest of the breakwater be not sufficiently high to prevent the shingle being forced over, it will be so forced over, and accumulate on the other side of the breakwater. I also apprehend that in the deeper water shingle would creep on to a certain extent with its progress between high and low-water mark.

If so, would not this be prevented by making the exterior slope of the breakwater a slope of 45 degrees or more with the horizon?—Certainly; but probably a much less slope, one which will not retain the shingles upon it, will be sufficient to counteract the presumed effects previously noticed.

(*Lieut.-Col. Colquhoun.*) From your knowledge of the southern coast of England, and the movement of the shingle, do you think its progress eastward can by any means be arrested?—As much of the portions of rock, from which the shingle is formed, is usually broken or dropped from cliffs in various places along the shore, and the shingle is only stopped from time to time by headlands projecting into deep water, beaches have local characters, according to the kind of pebbles of which they are composed, such characters being of any variable extent according to circumstances. From distance to distance, sometimes considerable, beaches are often now locally arrested, not readily passing round some headlands, the drifted shingle there accumulating in the deep water. You could only

arrest, to a very limited extent, the progress of such shingle in these distances; for if the supply be greater than your means of stoppage, it must necessarily accumulate and pass on. Sir *H. De la Beche.* 10th May, 1844.

Of the two plans, No. 1, with open entrances between the land and the breakwater, and No. 2, an enclosed harbour, with two entrances, in seven fathoms, which would be best preserved from the accumulation of shingle and the deposition of silt and detritus within the enclosure?—The plan No. 1, without reference to the tide-harbour.

Are you of opinion that it is desirable to have a double entrance or only one entrance?—If you were to close up all except the centre, the sediment would accumulate to a much greater extent, inasmuch as the power of removal would be decreased.

If the bottom is kept in a constant state of disturbance, do you apprehend there is any reasonable objection to constructing a harbour on this plan arising from any apprehension of its filling up?—Although accumulations would take place if such a plan were adopted, and you could stir up and mechanically suspend a certain amount of detritus which is borne into it, such accumulation would be small comparatively with that which would take place if no such extraordinary measures were adopted, it being always understood that the tidal current be sufficient to carry out the mud and silt thus caused artificially to be suspended in the water.

You are of opinion that a harbour of this description might be constructed without any apprehension of inconvenience from deposit?—To a certain extent, under the conditions previously mentioned; at the same time it would be a tremendous labour efficiently to stir up the sediment.

What would be the effect of a sill filling up the space between the bars 12 feet above the bottom?—I should apprehend that as the detritus would be carried into such a basin as that I see before me, in two ways; first, by the action of the waves causing it to be mechanically suspended in water; and secondly, by the current entering in and forcing the bottom along by friction; such a bar would not prevent the entrance of the greater portion of the mud, silt, and sand mechanically suspended in the first case, though it might arrest the progress of the sedimentary substances propelled by friction along the bottom until a fitting slope be formed in the second, provided that the action of the currrent of the flood tide would not so disturb the water as by its increased motion to cause the silt forced against the bar to be mechanically suspended and driven on; being once in, it cannot escape.

The effect would be to retain the mud to form a shoal?—Yes.

[*The Witness withdrew.*]

Adjourned.

RAMSGATE.

Tuesday, May 14th, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Kennett B. Martin, Harbour Master, examined. Mr. *Kennett B. Martin.* 14th May, 1844.

(*Chairman.*) You are harbour master of Ramsgate?—Yes.

How long have you been in that office?—I have been harbour master and deputy master 53 years.

How many trustees are there?—I believe there are 200, but I am not quite certain as to that.

Must there be that number, as the Act says there shall be?—I believe so.

How are they filled up, by election?—They are.

Do any of them reside on the spot?—Sir William Curtis is the only one residing here, and he does so only part of the year.

How often do the trustees attend personally to examine the harbour?—Once a-year; and sometimes they come on visits of inspection perhaps two or three times a-year.

Who looks after the harbour on the spot?—The deputy chairman, when here, and the harbour master.

Do you hold your appointment from the trustees?—Yes, I do.

The harbour has been in the course of improvement since the Act of 1815?—Since ever I can recollect it has always been improving progressively and constantly.

What is the greatest number of vessels you have ever known to be in the harbour at one time, exclusive of fishing vessels?—434 sail in the two harbours; 181 in the basin, and 253 in the outer harbour, making 434 sail altogether.

What is the whole space within the walls for accommodating the number of ships you have mentioned?—The outer area is 42 acres in extent, and the inner area 12 acres.

Can you give an account of the number of ships that came into the harbour within the last 20 years?—I can.

Can you say the number within the last three years?—1600 sail of merchant-

Mr. *Kennett B. Martin.*

14th May, 1844.

vessels on the average, exclusive of fishing-craft, the town boys, and the regular packets in the season.

Are you enabled to state how many came for mercantile intercourse with Ramsgate, leaving it to be inferred that all the others came in to wait favourable winds, or for repair?—I am not able to give an account from memory, but I sent in statistics showing these particulars.

If British vessels, particularly coasters, were better found in sails, rigging, and ground tackling, and more attention paid to their caulking, would it not diminish greatly the necessity for seeking harbours of refuge?—I have no doubt of it. They are also sometimes so overloaded as not to be able to ride.

What are the rates of the harbour dues?—2*d.* per ton on vessels under 300 tons, and ½*d.* per ton over and above that tonnage.

Where are the dues received?—At the Custom House.

Who receives the dues at this port?—The collector and one of the officers of the trust.

Do you know their average annual amount?—I do not; we have no account here of the amount of the revenues of the harbour. To speak from guess, I should say they were from 15,000*l.* to 20,000*l.* annually.

Do you know the average annual expenses?—No, I do not; but they have been very great of late years.

Have you sufficient back-water for your harbour?—It is considered by Sir John Rennie that it would be of great advantage to have it increased.

Increased by what means?—By an auxiliary dock or basin.

In what direction?—He (Sir John Rennie) proposes it to be to the westward of the harbour.

Would that scour these basins?—I thing he would give the best opinion on that subject.

Do you know the extent of the proposed additional harbour?—I do not.

Do you know the expense, or the estimate?—I do not.

If a narrow basin were made, could it be cleansed by an auxiliary one?—I think not, because the chalk is of unequal strata.

Could you not excavate?—We could not excavate the narrow basin.

What would be the result of a new basin?—It would be of great benefit to the outer harbour.

Would not the outer basin be of great advantage?—It would give more accommodation for ships, and give a greater back-water.

Does the ebbing tide, or the back-water, or the sluices tend to increase the shallowness of the water by the collection of sand or mud outside?—Not in the slightest degree.

What is the depth of water in the fair-way of the channel at low-water spring-tides?—Outside the area, from eight feet at the transporting buoy, gradually deepening up into the Small Downs; and I believe it is there from six or seven fathoms.

Do you ever attempt to deepen the water by dredging, and what is the nature of the bottom?—No. The bottom is of hard chalk rock.

Supposing the buckets of a dredging-vessel to be made small, and the lips powerfully armed, would not that reduce the chalk rock?—There is no question but that it would do so; it would take up the chalk by increasing the power of the engine.

Have you ever kept any account of the expenses of working the dredging-vessel?—I have inserted the account in those statistics which I sent to you. About 7*d.* a ton is all the expense of getting them into the lighters, discharging them from the same, and getting them back for their work alongside.

The deepening of the fair-way to the channel would not be of much advantage unless you deepen the entrance of the harbour?—I don't think it would.

Could you deepen the entrance of the harbour without disturbing the lower part of the wall?—You could not deepen it, as the wall stands on caissons at the surface of the chalk rock.

In what depth of water are the caissons?—At low-water spring-tides, at the western pier head, they are in from four to six feet; and at the east pier head, at from six to eight feet. They were placed there eighty years since.

Are they of wood or iron?—They are of Riga timber.

What are they covered with?—They have no covering whatever, as the work was carried on from the brickwork down to the floor-edge; but where they have been uncovered, they were perfectly sound; as much so as on the day they were placed there.

When blowing a gale of wind from the south, and a heavy sea setting into the Downs, is it generally during the time that the tide makes to the northward ships part their cables?—Certainly.

Then vessels so breaking adrift are sure to have the flowing tide for entering Ramsgate Harbour?—Yes.

Are you aware of a proposal to increase the Small Downs by extensive works along the Brake Sand?—I have heard of it.

The plan (*which was here shown to Mr. Martin*) shows the proposed entrance to be open to the southward, would it not be constantly exposed to the heavy sea which tumbles in from that quarter in blowing weather?—Yes, it would.

Do you think ships would there obtain shelter?—I have not had an opportunity of inspecting the plan. To the best of my recollection, vessels under the Brake would be sheltered from all winds.

Mr. *Kennett B. Martin.*

14th May, 1844.

What is the direction of the Brake Sand?—N.N.E. and S.S.W.

The proposed work along the Brake, being three miles and a-half in length, makes a passage between it and the shore, will this narrowing of space tend to produce greater velocity in the tides?—I should say it would.

If such an increase in the rise of the tides were to occur, and vessels were to ride there in southerly gales, would it not cause ships to ride harder in that anchorage than outside of it, where there is not so much tide?—I don't think it would, because the great increase of tide would be at the northern end, and not at the southern end. I do not think it would increase much at the southern end, where ships would ride.

I have been told that an increase of tide through the Brake would tend to diminish the shoals?—It would do so.

If it would be strong enough to do that, would it not be so strong as to be felt by the ships riding there?—In my opinion it would not be strong enough to injure ships riding there.

What do you suppose will become of the sand or mud that is to be carried away from the anchorage under the Brake; where will it be deposited?—It would go through the Cudd Channel into deep water, the easterly tide gradually assisting it, as it runs more than three hours after high water.

Would there be no reason to apprehend it setting in front of Ramsgate Harbour? I don't think there would.

It appears there is from 11 to 12 feet of water at the northern entrance at the Brake?—The average is 11 feet at low-water spring-tides.

Then, supposing a ship at anchor within the Brake anchorage to break adrift in a south-westerly gale, as she cannot pass through the northern channel, what is to become of her?—I consider that, in nine cases out of ten, vessels break adrift when there is water enough to enable them to pass through. We have many instances of ships breaking adrift in the Downs after high water, and passing through the Northern Channel, because the pilots doubt whether there is sufficient water in Ramsgate Harbour; and rather than risk going in there, they go round the land.

Supposing a ship to break adrift in the Downs, with the tide running to the northward, and flowing at Ramsgate, her course is sure?—She would go through the Gull Stream.

Supposing you are desired to select a place for a man-of-war rendezvous for giving protection to the trade of the Channel, would you propose the anchorage under the Brake?—I am not competent to answer that question.

Would you select that place?—It would depend entirely upon where the enemy's forces were.

Would men-of-war under the Brake be in a proper place to give protection to the trade of the Channel?—Not under all circumstances; it depends on circumstances.

Do you know anything of Dover?—Yes, I am a native of that place.

What do you know of it?—Dover Bay has very deep water, and it has also a moving shingle, which is a continual obstruction to its harbour; and I have always understood that if any means were taken to throw the shingle out into deep water, it would take away the beach from the Bay, and destroy the property situated there.

But if its harbour were increased, if it were surrounded by an artificial harbour, where the shingle could not get in, should you have any apprehension concerning the shingle or the beach then?—Certainly not.

Do you think Dover Bay a desirable position for a harbour of refuge?—It is the narrowest part of the Channel, and certainly a desirable position for such a harbour.

You see this map; here are three entrances, A, B, and C; do you consider that A, the western, would be likely to receive the shingle as it goes along, or that it would be better to stop up A and leave the opening more to the southward?—I consider it would be better to have the opening to the southward.

For ships coming up Channel and running to this proposed harbour, where would be the best place for an entrance?—The centre of the Bay.

Would you recommend an opening to the eastward?—I should recommend an opening to the eastward to any harbour, that the tide might go through it.

When you are under the Brake Sand what water is there to the northward at dead low-water spring-tides?—Nine feet at the lowest, and 11 is the average.

Then that never could admit vessels to pass through, drawing 18 feet water at all times of tide?—Certainly not.

(*Adm. Dundas.*) In the event of war, it would be necessary to have a capacious harbour, where vessels could be sheltered from all winds and weathers, and where vessels of war or war steamers might constantly be ready to slip out at a moment's notice, for the protection of the trade and the defence of the coast. For the construction of a harbour, combining with the above objects that of being a harbour of refuge for merchant-vessels, on what spot would you fix?—I should prefer Dungeness. The French have harbours more to the eastward, but I should consider Dungeness the best site; and if it were possible to have another such harbour also, I would have it at the Downs, for then the whole Channel would be completely at the command of these two places.

What sort of holding-ground is there in Dover Bay?—Very bad; it is chalk bottom in seven fathoms, and silt close in.

Is that at Dungeness good?—It certainly is better.

Mr. *Kennett B. Martin.*

14th May, 1844.

What water have you at the mouth of Ramsgate Harbour at dead low-water spring-tides?—Six feet between the piers.

Supposing you have additional water to sluice off, would that make any real difference at mouth of the harbour?—Not without the assistance of the dredging-machines.

What is your reason for preferring Dungeness for the construction of a harbour of refuge to Dover?—Because it has a greater command of the Channel, is farther to the westward, is nearer to the Channel Islands.

Supposing a fleet of merchant-ships to be at anchor in the Downs, which would be the most favourable position for their protection, Dover or Dungeness?—I should prefer Dover, as being nearer to the Downs.

Then for aggression you would choose Dungeness, and for protection to commerce you would choose Dover?—Dover would be better than Dungeness for the protection of the commerce in the Downs; but Martello towers on the Brake Sand would be better still.

How are vessels coming down the river with a south-west wind to get into such a harbour as Dungeness?—They would not attempt to work through the narrows as long as they could have a safe anchorage in the Downs.

(*Chairman.*) Supposing that a fleet of merchant-vessels are obliged to take shelter, is it your opinion they would take shelter within the Brake Sand, or attempt to go to Dungeness Harbour?—Certainly they would take shelter at the Brake Sand, because their greatest risk would be between the Downs and Dungeness.

Then you would prefer Dover as a harbour for a fleet of men-of-war to lie there to give protection to the trade; but you would prefer the proposed harbour within the Brake as a better harbour for trading-vessels to lie in?—The best means of protection would be for the cruisers to be with the trading-vessels.

Do you not think the cruisers would be better to be outside the merchant-ships?—No, I do not.

You have heard of the proposed harbour at Foreness?—I have.

Do you not think vessels would be more accommodated there than at the proposed harbour within the Brake?—No, I do not.

Do you know anything of the ground about Beachy Head?—I know it perfectly well.

If you were to have a breakwater at Beachy Head, which side would you prefer it to be constructed on?—There would be great difficulty on either side, on account of the heavy sea; but I would prefer the westward side, about Newhaven.

Is not the prevailing wind, at least for nine months of the year, to the westward?—From south-west to north-west are the prevalent winds.

Then, with the prevailing wind to the westward, would it not be better to have the harbour to the east of the Head?—It depends on the formation of that harbour or breakwater. If the breakwater was to be placed to the westward, then it would be of advantage to have the harbour to the westward.

Do you know enough of Newhaven to say why it is preferable for a harbour?—I am not sufficiently acquainted with it to do so. I have heard it spoken well of.

Does not a heavy sea tumble in to the westward, while to the eastward there is only a ground-swell, and it is sheltered?—We never trusted ourselves there when I served in the hired armed service at the Beachy Head station; we were rather afraid of it.

Whether would you prefer running to the bight on a lee shore, or to go under the shelter of the land to a port on the other side?—Certainly not on a lee shore; I should expect to find a harbour free of access.

In the case of vessels breaking adrift from the Small Downs, in strong westerly winds, with the stream running last quarter flood, would they find falling water in Ramsgate Harbour, or in the channel leading out to the north of the Brake?—Yes, they would.

(*Admiral Dundas.*) Could a ship-of-war go to sea in all weathers, with all winds, and at all times of tide, from a harbour of refuge constructed at the Little Downs?—It depends on their draught of water; if they could navigate the Channel they might.

As a person having experience in this neighbourhood, to which would you give the preference for the construction of a harbour of refuge, accessible at all times of tide, within the Brake or Dover Roads?—I should prefer a harbour inside the Brake, because we have no shingle there.

Looking at the present anchorage in the Small Downs, and to the protection that could be given from the shore, do you consider that a harbour of refuge for men-of-war to remain in for the protection of the trade in general would not be preferable in Dover Roads to the Small Downs?—I should prefer a harbour for such purposes being constructed in the Downs.

Explain how a squadron at the Brake could give protection to the Channel?—For protection to the trade of the Channel, Dover would be better than the Small Downs.

Would a squadron of steam-vessels within such a harbour as the proposed one at Dungeness protect the merchant-vessels in the Downs better than a squadron of steam-vessels within a similar harbour at Dover could do?—The subject does not admit of a question; but again I should prefer the Brake Sand to either for the protection of the Narrows.

Would not the position at Dover place a squadron in a better situation to intercept than that of the Brake?—Then I should say it would, but I was confining my evidence to the Small Downs.

Which would you prefer for a harbour for men-of-war to enter and remain in for the protection of that part of the Channel, Dover, or Dungeness?—I should prefer Dungeness; because I consider it has the greatest command of the Narrow seas.

(*Chairman.*) What is the distance from the South Sand Head to Dungeness?—I should think it is about 23 miles.

Do you think a squadron stationed at Dungeness would be in a situation to give effectual protection to a fleet of merchant-men in the Downs?—I do not.

What is the distance from South Sand Head to Dover?—About five miles, and from Dover to Dungeness about 18 miles more.

Then the protecting squadron would have five miles to run to afford protection if stationed at Dover, and 18 miles additional if stationed at Dungeness?—Certainly, if the fleet to be protected were in the Downs.

In that case, which locality would you select for a harbour of refuge?—I would prefer the nearest, allowing for the alteration in transit caused of late by means of steam, the difference in the respective distances from the Downs would be more matter of consideration; but our cruisers during the last war always preferred Dungeness as a point to watch from, that they might give protection to the trade of the Channel with the greatest effect.

I wish to ask you whether you consider that the Royal Sovereign Shoal, and other shoals about it, would not be an impediment to your making a breakwater to the eastward of Beachy Head?—They certainly would.

(*Capt. Washington.*) You said that during the war Dungeness was the best station for cruizers to protect the Channel?—It was considered so.

Was that not chiefly owing to its being to windward in the prevalent winds?—It was.

And since the establishment of steamers, that advantage has been lost?—Not altogether; steam-boats like fair winds. A steam-vessel would tow away a prize better when she could get her canvass to help her engines.

Would not Dover, as a naval point, be better able to protect ships in the North Sea and the Channel than a place 20 miles further to the westward?—In the North Sea, but not in the Channel.

(*Capt. Fisher.*) You say that you were employed during the war to protect the Channel while you served in a cruizer; was there not then generally a large fleet of men-of-war in the Downs?—Generally; but all the fast cruizers were at Dungeness. All those cruizers which had to look after the privateers were stationed at Dungeness.

Do you consider that ships in the Downs were a natural defence to the mouth of the River?—Certainly.

To what winds in the Small Downs are ships most exposed?—From S.S.W. to S.S.E.

What is the protection against other winds?—The South Foreland from the south-west westerly, and the Goodwin Sands from the south-east easterly.

Do you consider that these natural protections are sufficient against all other winds in all weather?—Yes; except they are very heavy, or hurricanes.

As you say the anchorage within the Brake is open to the S.S.W., does not the wind from that quarter bring in a heavy sea?—I think the wind from the south brings in a heavy sea.

(*Sir H. Pelly.*) The Goodwin Sands and the proposed work lying along the Brake in a S.S.W. direction would be nearly in a parallel direction?—I have not examined the plan sufficiently to answer that question. It would appear so from this plan.

The Goodwin Sands are a great protection from outward winds?—Yes, they are from S.E. easterly.

You stated that the anchorage in the Little Downs was open from S.S.W. to S.S.E., and that it embraces four points of the compass; to be more secure in your answer to the second question, you said that the Foreland protected from S.W., and the Goodwin from the S.E., making 8 points of the compass. Now, supposing a breakwater to be laid down in that direction, so as to cover 8 points in the Brake, would that not be a complete protection to vessels within the Brake?—Certainly.

(*Chairman.*) Could vessels get out of the North Channel at all times of the tide?—They could not.

What is the rise of tide required for vessels drawing 18 feet water in order to pass out of the North Channel?—Such a vessel might go out at half flood.

You are well acquainted with the power of steam?—I am perfectly well acquainted with it.

Have you ever found south westerly gales to be so heavy between here and Dungeness that a powerful steamer could not face it?—It must be a very large class steamer that would face a south westerly gale in the Narrows.

Suppose there were a refuge harbour in Dover Bay, could not a powerful steam-vessel then get up to Dungeness from that harbour in any weather?—It must be a powerful one to be able to do so.

You said that if a breakwater were to be run out from the south end of the Brake towards the shore that it would give protection?—I should have no apprehension of shingle passing through the opening into the anchorage; I should think there would not be any shingle there.

Mr. *Kennett B. Martin.*

14th May, 1844.

I wish to ask you whether in hard gales of wind from N.N.W. to N.N.E. there is not a heavy swell, as heavy as from the S.S.W. ?—Not in the Small Downs, but there is in the Great Downs.

[*The Witness withdrew.*]

Mr. *Thomas Aylesbury.*

Thomas Aylesbury, called in and examined.

(*Chairman.*) In what capacity are you serving ?—I am warden of the Cinque Ports pilots at Ramsgate.

How long have you held that office ?—I think about 10 or 12 years, and I have been a pilot 24 years.

Are you well acquainted with the anchorage about Foreness ?—Pretty well.

Have you seen the plan for a proposed harbour at Foreness ?—I have not.

(*Plan here shown Witness.*)—Does the trade coming from the North Sea make the North Foreland ?—No ; they frequently make the lights of the Goodwin.

Supposing a fleet of ships to be at anchor in the proposed harbour outward bound, and the wind coming from the eastward, how can they get out of it ?—Then they might with difficulty by getting round Long Nose Buoy.

How far is the entrance of the harbour from the edge of Margate Sand ?—About 5 miles.

How would vessels get out into the fair-way of the Channel with a heavy sea and the wind at N.N.E. or N.E. ?—They would get out with great difficulty, the wind blowing hard.

In point of fact, could a fleet of convoy ships depart from the proposed harbour with the wind at N.N.E. ?—In a gale of wind they could not, but in fine weather they could.

Should you from your experience think Long Nose a desirable position for a harbour of refuge for the trade of the country ?—I should not.

Why not ?—It is a bad position and on the wrong side of the Foreland.

Have you seen the plan of a harbour within the Brake Sand ?—I have never seen one.

(*Witness was here shown the plan.*)—You see the plan is to construct a work along the whole length of the Brake Sand. Suppose that a ship at anchor within the Brake parts her cable in a gale of wind, inside the buoy of the Brake where the proposed harbour would be at night time, what is to become of her ; I mean a ship drawing 18 feet water, can she get to the northward ?—No, she cannot ; but she could at the top of high water, or even an hour before or after.

What is the least depth of water in the fair open anchorage near the fair-way buoy ?—To the southward of the buoy 4, 5, and 7 fathoms.

Would the present depth of water at the fair-way of the North Channel permit a vessel passing out drawing 18 feet water ?—No.

Have you been accustomed to the south-eastern coast ?—About Beachy Head, I have.

What is the depth of water in the Cudd Channel ?—Nine feet in low-water spring-tides.

What is the rise of water ?—In ordinary tides it is 10 or 12 feet ; and 16 or 17 is the depth with spring-tides, making about 25 feet at high water.

You stated that at low-water spring-tides there was only 9 feet water in the Cudd Channel, could you not take a ship out at an earlier period than half flood ?—It might be possible, but I would not attempt it.

You know the coast of Kent well ?—Yes, about Dover and Dungeness ; but I have not been in the neighbourhood of Dungeness much lately.

(*Adm. Dundas.*) In the event of war, as it would be necessary to have a harbour for steamers to be constantly ready to slip out at a moment's notice night and day for the protection of the trade and the defence of the coast, and to combine that object with that of being a harbour of refuge for merchant-vessels, at what place would you recommend that such harbour of refuge should be constructed ?—As near the south Foreland as possible, or Dover.

If you made a harbour at Dover, where would you form your entrance into that harbour ?—I should place an entrance towards the south-west end, in order that ships might lie out on the larboard tack with the wind S.E.

Supposing you were to continue Cheeseman's Head out seaward into six fathoms water, would you prefer that it should be a close pier or an open one that the shingle might pass through ?—I should prefer that it be closed up.

Supposing another entrance were to be made, where would you place such entrance ?—I should not propose a second entrance myself.

Are you acquainted with Beachy Head ?—I know it very well, as I have navigated there, and served my time in the coasting trade.

If a harbour were to be constructed in that neighbourhood, about what place would you erect it ?—To the westward, about Newhaven, because I should think ships would be able to get out from there with a fair wind going down Channel.

You would prefer an making artificial harbour about Newhaven.—Yes.

Mr. *Thomas Aylesbury.*

14th May, 1844.

As a seafaring man, in a south-westerly gale and you off Beachy Head, which would you rather find, a harbour constructed surrounding Newhaven, or one on the other side of Beachy Head to the eastward?—One to the eastward would be better to run for, because Newhaven lies in a bay on a lee shore.

Supposing Newhaven to be surrounded with a deep-water harbour, should you then have any fear of running on a lee shore?—There would be fear of running on a lee shore, but I would guard against it by heaving my ship to in time.

(*Capt. Fisher.*) Do many ships anchor at Beachy Head?—Merely to stop tide.

Supposing that you were called up to fix on a position which you would think best, in the narrow part of the Channel, beginning, for instance, from the North Foreland down to the Isle of Wight, for the construction of a harbour in which a squadron of men-of-war steamers might give protection to the trade of the Channel, where would you place it?—At Dover.

And supposing the two places were required for the steamers to lie in to render protection to the Channel, and, at the same, to be convenient for the trade, where would you then place them?—In my opinion there ought to be one at Dover, and the other at Dungeness, about the East Bay.

To what points of the compass is the anchorage in the Downs most exposed?—From S.S.W. to S. by E.

How long does the stream tide run to the eastward after high water by the shore?—About three hours.

Then supposing a ship to break adrift from the Little Downs, after half flood by the stream, would she find falling water about Ramsgate, and in the passage out to the Northward?—Yes, she would.

Do you consider a safe passage out could be made for ships breaking adrift in the Little Downs at all times of the tide?—It could be made better than it is; but I am not quite competent to answer that question.

Are you acquainted with the opposite coast?—I know something of it.

Do you know if the shingle travels there?—No, it does not, between Cape Grisnez and the Texel.

Is there no shingle at all there?—None; there is sand on that coast.

(*Sir W. Symonds.*) What description of holding-ground do you have at Dungeness?—Good holding-ground.

What is its quality at Dover?—Not quite so good, as it is rather hard.

If there were large pier harbours constructed both at Dover and Dungeness, and you were in a small bad sailing merchant-vessel, which of the two harbours would you anchor in, Dungeness or Dover?—In that case I should go to Dungeness for shelter.

Then you think the proposed harbour at Dungeness would be safest for small vessels?—Yes, I do; because there they would have to encounter less tide than at Dover.

At night, I particularly wish to ask you, which would you soonest go to, a harbour under low land, as Dungeness, or a harbour under high land, as at Dover?—At night I should go under the high land at Dover.

What is the difference in the wind under the high lands and low lands?—The wind is more true under low land than it is under high land.

Should you experience baffling winds under high or low lands?—High lands.

(*Admiral Dundas.*) Do you know anything about steam-vessels?—Yes, I have commanded one.

In a gale of wind could a powerful steam-vessel go from Dover to Dungeness, with the wind at S.W.?—In an ordinary gale she could.

Is there any silting in Ramsgate Harbour?—A little.

What do you think it arises from?—It is my opinion it comes from Sandwich Haven.

You have named Dover as a place suitable for the harbour of refuge, do you apprehend that it being inclosed would cause it to become filled up?—I think it would in a measure, and that it would require artificial means to keep it clear.

Supposing a pier or break-water to be made on the Brake Sand, and inclosed also, do you think it would be liable to become filled up?—It would, in certain parts of it.

You said you recommended only one entrance to a harbour at Dover?—Yes.

Supposing it had another entrance to the eastward, would that reduce the tendency of the harbour to silt up?—It would do so, but it would give a greater range of sea in the harbour.

If two entrances were made, how would it cause a greater sea inside the harbour?—By the current passing from the one to the other, taking the sea with it across the dead wall.

Knowing the prevalence of westerly and S.W. winds at Dover, and looking at the plans now before you, do you think there would be any difficulty in a ship entering the proposed harbour at all times of tide and all winds?—With two entrances there would be no difficulty.

Referring again to the last question, what do you think would be ample width for the western entrance to enable the largest ships to come in at all winds excepting the S.E.?—Six hundred or seven hundred feet.

(*Chairman.*) Alluding to the proposed work along the Brake, supposing, contrary to your expectation, it should increase the run of the tide so as to sweep away the shoals, what would become of the sand and shoal stuff?—It would be carried away by the tide to the northward, or to the Quern shoals.

Mr. *Thomas Aylesbury.*

14th May, 1844.

Do you think it would come to the mouth of the harbour of Ramsgate?—I think it would come near the Cudd.

Have you any reason to suppose that the Brake Sand has altered its situation?—Not materially; but I think it has altered a little to the southward; the south Brake-head extends farther to the southward than it did 30 years ago.

Do you not consider it has shifted bodily to the westward a considerable distance?—I think not in shore.

Have the buoys not been moved?—I believe the south buoy has been moved.

Are there any marks inside to keep you clear of the Brake Sand?—Yes; the same as there were twenty-four years ago.

What depth of water would you find at the Fair-way buoy at low-water spring-tides?—From 11 to 12 feet.

What is the distance to that buoy from the entrance of Ramsgate Harbour?—About 3 miles.

During those 3 miles have you no deeper water than is to be found at the Fair-way buoy?—Yes there is.

What is the general feature of the soundings?—Varying from 2 to 2½ fathoms.

Have you any deeper water towards the Brake?—Yes; to the southward.

Abreast of the Fair-way buoy, is the water deeper or shoaler in towards the Brake?—I should say it is shoaler.

Have you ever been along the edge of the Brake?—Yes.

Is there less water along the edge of the Brake than 2¼ fathoms?—Yes; there is less water than that.

[*The Witness withdrew.*]

Mr. *Werter Clark.*

Mr. *Werter Clark,* called in and examined.

(*Chairman.*) In what situation are you?—I am a Cinque Ports pilot.

How far does your branch extend?—To Gravesend in the river Thames, to Standgate Creek in the Medway, to the Owers in the Channel, to the Texel along the coast of Holland and Flanders, and Boulogne on the coast of France.

If you were required to fix on a place the most suitable to serve as a rendezvous for a squadron of war-steamers for the protection of the Channel trade in the time of war, and at the same time to serve for a harbour of refuge for the convenience of the state, what situation between the North Foreland and the Owers Light would you select?—Dover Bay.

Have you ever heard of a project for including the Small Downs, by a work along the Brake?—I have heard of it.

Do you think such a work extending along the whole length of the Brake would make a desirable harbour for war purposes and the convenience of the trade?—I do not; I do not think there would be sufficient water for large vessels excepting at the entrance, and again those vessels lying at the southern part would be much exposed to northerly winds generally.

What is the effect of N.N.W. and northerly winds?—They have a great length of distance in the fetch, being so distant from the land as at times to cause a nasty sea; and vessels drive from their anchors in gales with the wind at N.N.W.

You say these winds occasion much sea?—They cause a very nasty sea, and hard riding, as the ground in that part of the Downs is not very good, and is in many parts chalky.

In the Northern Channel, between Ramsgate and the Brake, what water have you?—Nine feet at low-water spring-tides.

At what time can vessels drawing 18 feet water pass into Ramsgate?—It depends on the tide; they could not at all in neap-tides.

Could not the same tide that gives water over the Channel shoals give water to the harbour?—No; there is more water over the shoals than at the harbour.

How many years have you been in the habit of piloting the Channel?—Almost the whole time I have been at sea; and I have been at sea 38 years.

Have you been much in the neighbourhood of Beachy Head during that time?—Not much; I have been more about the Downs and the North Sea.

You have mentioned Dover as a place you would prefer for an artificial harbour, which place would you consider the best for another such harbour as the proposed one at Dover, for war purposes, and for large commercial vessels?—I know of no other eligible point.

Are you a native of Dover?—I am.

Which has the best holding-ground, Dungeness or Dover?—Dungeness has.

(*Admiral Dundas.*) You know a good deal about steam, in a gale of wind from the S.W., taking advantage of the tide, could a steam-vessel get from Dover to Dungeness?—Generally speaking, she could. There are sometimes gales when she would not be able to face them; but I think she would be able to proceed thither in moderate gales.

Do you know anything of the intended harbour at Foreness?—Nothing farther than what I have seen to day.

Were you ever at Beachy Head in a gale?—Yes, I have.

How was the wind?—I have been there in S.W. and southerly gales.

What are the prevailing winds in this part of the Channel, are they S.W. and S.?—Yes, they are.

Mr. *Werter Clark.*

14th May, 1844.

On which side of the Head would you make a harbour?—On the eastern side.

Have you ever been at anchor in Eastbourne Bay?—Yes.

Do you think the Royal Sovereign Shoal in the way of making a harbour there?—No, I do not.

How far is the Royal Sovereign Shoal from the land?—I think about 5 miles.

Were you ever at anchor at Newhaven Harbour, inside?—I have never been inside the harbour; but I have been at anchor in Seaford Roads.

Do you know the nature of the ground?—I have not been there sufficiently often to know its nature.

Knowing the prevailing winds to be westerly, which would you say would be the most advisable situation for a harbour for the protection of the Channel, the eastern or the western side of the Head?—I should prefer the eastern side.

Speaking of the Brake, do you think there has been any diminution in the depth of water within the Brake?—I think not; the Brake towards the Middle Buoy, or Chequered Buoy, seems to have gone in towards the land since I can recollect.

You said you were a good deal employed in the North Sea, would the proposed harbour at Foreness be of advantage to vessels going up the River or down Channel?—I do not think it would.

You stated that you would prefer a harbour in Dover Roads, can you give us your reasons for this choice?—I should prefer a harbour of refuge at Dover, because of its proximity to the opposite coast in one respect, and also on account of its fortified situation.

You would prefer it from its nearness to the opposite coast?—Yes; and another reason is, that vessels from the Downs with neap or common tides could attain that harbour when they could not get to one if it was farther to the westward. It must be an indifferent vessel that would not reach such a harbour at Dover in a common tide.

Do you mean to say that if it was blowing strong, vessels could get into that harbour?—I do.

You mean in such weather as a ship could make way with?—Yes; and I should consider it more easy of access to vessels proceeding to the westward than one farther west.

(*Capt. Fisher.*) You say that the Brake has shifted within your knowledge: are you aware whether there is any difference in the leading marks?—There are no marks for leading along the Brake: but only to lead the way through the Gull Stream.

Then I wish to ask you what are your marks in running down inside the Brake in a dark night?—I generally find my position before dark, and am guided by the compass in getting my position till I advance towards the harbour.

Is it not the case that in running down inside the Brake, keeping the North Foreland Light just open, and occasionally shut in, has been the guide for the last 30 years?—I should say, that if I were to attempt to shut the North Foreland Light in when a vessel first enters between the South Brake Buoy and Sandown Castle, I must run her a-shore, on the main.

I wish to ask you, with respect to the north passage into the Brake, at what time of tide a ship drawing 17 feet of water can pass over?—It ought to be within two hours of high-water, speaking of spring-tides.

Supposing a harbour of refuge to be constructed at Dover, can you give us any idea of what you consider a proper width for a southern entrance, as shown upon the plan now before you?—I should say about 800 feet.

Do you think that the entrance as shown upon the plan is in a proper situation?—I think it would be better in the centre.

Would you prefer a second entrance also?—I should like an eastern entrance also; because vessels with easterly winds might take shelter in the proposed harbour, as they do now anchor in Dover Roads frequently; and then with southerly or westerly winds, they would have a fair outlet to the eastward.

Do you think the shingle would pass into deep water if a pier was run out?—I think it would.

And that, by having the principal entrance more in the middle of the harbour, there would be no fear of the shingle entering the harbour?—With the entrance about the centre of the harbour, I think the shingle would not enter in, which might be the case with it farther to the westward.

DOVER.

Thursday, 16th May, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *Stephen Norris.*

16th May, 1844.

Stephen Norris, called in and examined.

(*Chairman.*) Are you a branch pilot at Deal?—I am.

Extending how far?—To the west end of the Owers and the Texel.

How long have you held your branch?—Forty-one years next September.

And you do still?—Yes; I am one of the wardens.

Are you well acquainted with the anchorage within the Brake Sand in the Downs?—Yes; very well.

Do you think there has been any change or movement in the Sand of late?—I have not found any outside the Sand; but inside the Sand, it is doubtful whether it has or not.

Do you consider the anchorage within the Brake a good and proper anchorage for vessels of all draughts of water?—It is not safe for vessels of large draught in its present state.

What do you mean by saying "not in its present state"?—That, in the case of a ship going adrift there is no outlet for her to the northward.

Speaking generally of the anchorage within the Brake, what is the least depth of water in spring-tides, in any part of the Small Downs?—From the Brake to the Castle you find it is from seven, five, and four fathoms, regular to the shore; and a mile further there is rather less water, for there it is from six to five, and from four to three fathoms to the shore at low-water spring-tides.

Which is the heaviest sea you have in the Small Downs?—It is most felt from S.S.W.; the wind at N.N.W. being off the land, ships can ride safe.

Is there any considerable sea sent down with the wind at N.N.W.?—The Small Downs is the best place for riding a ship with the wind at N.N.W.

Should you think it more desirable to have the Small Downs converted into a harbour by a work extending along the whole length of the Brake Sand; or, from your knowledge and experience, would you prefer one at Dover?—I shall give you my candid opinion, the Small Downs is a good and safe place; but in case of accident, by ship breaking adrift, there is no outlet for her to the northward, if she is not of a small draught of water.

Is not the Little Downs as safe and as good an anchorage, as far as a S.S.W. gale is concerned, in its present state as it would be with a work along the Brake?—It is for a small ship, but not for a large one.

If carried along the Brake only it would be no protection?—It would not with the wind at S.S.W.

(*Admiral Dundas.*) Mr. Norris, in the event of war it would be necessary to have a harbour on the coast of Kent, where war steamers could be sheltered from all winds and all weathers, and to be constantly ready, night or day, to slip out at a moment's notice for the protection of the trade of the coast; and to combine with that object that of being a harbour of refuge for merchant-vessels, at what spot on the coast of Kent, from Beachy Head to the North Foreland, would you say such a harbour, to be accessible at all times of tide and in all weathers, ought to be constructed?—I should consider Dover the most eligible situation for such a harbour.

In a gale of wind at S.W., could a powerful steam-vessel get down from Dover to Dungeness?—Yes; a powerful steamer might.

Do you know anything of Beachy Head?—Not much.

With a sea-wall along the Brake, and a breakwater at S.S.W., could the anchorage under the Brake be made a harbour of refuge, accessible at all times of tide, night or day?—No; it could not.

(*Sir Henry Pelly.*) Would not a breakwater drawn from Sandown Castle towards the South Brake Buoy, and so protecting the vessels within that line from S.S.W. winds, and sheltering them by another breakwater from S.E. winds, form a good harbour of refuge?—It would be a capital harbour for outward-bound ships.

Would it not be accessible at all times of tide, and in all winds, to steamers both in and out, at that one opening?—There certainly would be nothing to hinder it answering such purposes.

And vessels drawing 18 feet water in its present state would be able to get out?—They would never get out to the northward, excepting at high-water spring-tides.

What water is there in the Cudd Channel?—At low-water spring-tides no more than eight feet; and the rise of the tide is 18 feet at spring-tides.

Therefore at the top of high water a vessel would have 26 feet water to go out by?—Certainly.

I am speaking of a breakwater, independent of the line along the Brake, Supposing this line to be carried a little further to the westward, towards Deal, and carried in the same line across, would not that make an additional capacious harbour for vessels of all descriptions?—I should say that all ships might ride there.

(*Captain Fisher.*) I believe you answered a question put to you, as to which situation you would prefer a harbour of refuge to be constructed at between the North Fore-

land and Beachy Head, capable of receiving outward and homeward bound ships of any burthen, and also men-of-war, at all times of tide, by selecting Dover?—Yes; I did. Mr. *Stephen Norris.* 16th May, 1844.

Supposing a ship to break from her anchors in any harbour constructed in the Little Downs at any time between half-flood and half-ebb by the stream, would she find falling water both at the entrance of Ramsgate Harbour and at the passage leading out to the northward of the Brake?—Certainly the water would be falling.

Are you aware of any means that could be found for making these channels to the northward of the Brake available for vessels of the description already stated to you, and to render them navigable by night, supposing these passages to be deepened?—If the passages were deepened, you could certainly place lights.

Are they of such a nature as to be made available by marks on the shore?—I think they might be deepened to be rendered navigable.

(*Sir Henry Pelly.*) Is not the light on the pier head, with the light on the shore, now the mark for running out?—It is, and ships always run out by it.

Then supposing a ship breaks adrift from the Downs, with these marks could she not go through the Cudd Channel?—Certainly, she could with these lights if the weather was clear, so as they might be visible.

Would the same marks in the present state of the Cudd Channel carry a vessel through it from the Little Downs?—No.

What depth of water would you now find in passing out from the Little Downs to the north of the Brake at any time within two hours of high water?—After I got down to the Fairway Buoy, I should find very little; there might be from 14 to 15 feet.

(*Capt. Fisher.*) As a pilot of long experience on this coast, from which place do you consider a fleet of merchant-ships or single vessels detained by stress of weather could make their passage down Channel, from a harbour of refuge constructed in Dover Roads or one constructed on the east side of Dungeness?—They would from Dover Roads, because, with the wind southerly and easterly, they would not be able to get out of Dungeness.

(*Sir William Symonds.*) Look at this chart. Would a ship making sail from a harbour, constructed on the east side of Dungeness, have to make a course three points more to the southward, in rounding the point, than she would from a harbour constructed at Dover?—Certainly she would.

Look at the plan, and see the extent of the proposed breakwaters forming a harbour of refuge at Dover; and as an old experienced pilot, state what is the nature of the ground at four distinct points which I will mark, and say whether in all of those situations you would bring a large ship up, which would generally be necessary in an anchorage crowded with vessels taking shelter?—At the eastern section of the anchorage there is chalk; at the second, about the Castle Jetty, sand; at the third, to the westward, near Guildford Battery, mud; and at the fourth, mud still. I would not bring up short a large ship on the chalk.

Do you consider that in light baffling winds it would be possible to get a large fleet of merchant-ships inwards, through the opening to the southward, when either flood or ebb-tides are passing across the entrance?—I should think not, with a large fleet.

What is the rate of the tide-stream on the line where seven fathoms would be found at low-water spring-tides?—I should think three and a half knots.

Should a strong gale spring up from N. to N.W., could heavy merchant-vessels work in at either entrance in the night or day, the harbour being crowded?—It would be doubtful whether she could. If the harbour was crowded, I should think it would be dangerous to work a ship in.

Could a heavy sailing merchant-vessel get out at either entrance, if it were to blow a heavy gale from S.E.?—She could; I see nothing to hinder her.

So as to prosecute her voyage down Channel?—Yes.

What is the quality of the holding-ground to the eastward of Dungeness, where ships anchor?—It is mud, and is very excellent holding-ground.

Supposing a breakwater, two miles long, were made to shelter ships, similar to the one shown you with the winds from S.W. to north and by east, in seven fathoms at low-water spring-tides, would that in your opinion make a good harbour of refuge for large fleets of merchant-men, attended by steamers and other ships of war?—Yes.

(*Chairman.*) You have stated the difficulties of entering the projected harbour at Dover in blowing heavy weather, and the harbour in a crowded state; I ask you, would not the same difficulties exist in any other crowded harbour?—Yes.

(*Admiral Dundas.*) Which of the four sections of the anchorage in the proposed harbour at Dover Bay has chalk bottom?—The one nearest the Foreland.

In running into the harbour with a gale from W.S.W., would you have an entrance to the westward, that your ship might shoot in?—I would.

Supposing she lets go her anchor, does she drive up hill?—Yes.

With the assistance of steam-tugs, could any number of ships be taken in and out of the harbour?—Yes, they could.

And with the wind at N.W., ships would find shelter as they do now in any part of the harbour?—They would.

In winds from N.W. or N.E., or in light baffling winds, vessels might go in or out in any weather?—Yes.

(*Sir Henry Pelly.*) Would not the same wind that would enable a ship to go down Channel, permit her to go out of the proposed harbour?—Yes, it would.

Mr. *Stephen Norris.*
16th May, 1844.

(*Captain Washington.*) Have you been in the habit of bringing ships into Dover Road?—Yes.

Do ships often bring up in Dover Bay?—Not unless the wind is at N.E.

Have you ever seen a ship drive from her anchor in Dover Bay, between Cheeseman's Head and the Cornhill Coast Guard Station?—Never.

You said the rate of the tides was three and a half knots on the springs; have you ever measured it?—I have on many occasions done so, and found it to be even four knots, but not generally speaking.

Do you not consider the present anchorage in Dungeness, East Bay, in south-westerly gales, very good?—It is excellent holding-ground, and a ship may ride there long enough if she has got good chains.

Do you think there is sufficient room there for 200 ships?—Yes, there is.

How long before high water in Dover Bay by the shore does the tide-stream turn to the N.E.?—When it is half-flood by the shore.

(*Chairman.*) Are you residing at Deal?—I am a native of Deal, and it is my place of residence.

Have you any interest in connexion with Dover?—Not a bit of it: I should speak of any place, did I think it most suitable to benefit the country.

Looking at the plan for a harbour of refuge at Dover, and supposing the breakwater from Cheeseman's Head to be carried out into six fathoms water at low-water spring-tides, do you think the shingle in south-westerly gales would be likely to get into the harbour?—I should think not; but I should consider it better to carry the breakwater into seven fathoms water.

Why should you prefer its being carried out into seven fathoms water; is it in reference to the shingle, or to give a greater scope of anchorage inside the harbour?—I wish to afford a greater scope of anchorage.

(*Sir Howard Douglas.*) Looking at the plan now before you, showing three different places of entrance, where do you think would be the best position for a western entrance, for an easy and convenient ingress to shipping in a south-westerly gale?—In the centre, which is 600 yards eastward of the line of Cheeseman's Head.

Supposing Dover Bay to be enclosed with a breakwater, how many entrances would you have to it?—I should prefer two entrances: in addition to the central entrance I should recommend an eastern entrance, about 700 yards from the shore.

(*Chairman.*) Do you think a passage between high and low-water mark for the tide to pass through would be desirable?—I do.

Supposing there was no passage between high and low-water mark, do you think the shingle would accumulate in the N.N.E. corner of the harbour?—I should think it would drive up in the corner.

(*Captain Washington.*) Supposing a breakwater were to be formed, which of the spaces would you prefer?—I should select the outer seven fathom breakwater.

Is your reason for carrying it into deep water that it might accommodate ships of the largest class?—Yes, it is.

(*Captain Fisher.*) With your experience of 40 years on this station, where you have had much anchorage, would you have any hesitation, consistent with your duty for the safety of the vessel in your charge, in taking her into the proposed harbour at Dover during a gale of wind?—Certainly not.

Why do you prefer the central entrance that you have selected to the proposed harbour, would it permit vessels to sail out in any wind that would take them down Channel?—Yes; they could sail out of it with the wind at S.W.

(*Mr. Walker.*) Your attention has been particularly directed to the position of the entrance. Knowing Ramsgate Harbour entrance to be 200 feet width, what width do you consider the western entrance of the proposed harbour should be?—I should say it ought at least to be 600 feet wide.

(*Lieutenant Col. Colquhoun.*) How wide would you have your eastern entrance?—I should think 400 feet would be wide enough.

(*Mr. Walker.*) You said something about the tide clearing the eastern entrance; what did you mean when you said you would require an eastern entrance to keep the harbour clear?—I was speaking of the beach.

[*The Witness withdrew.*]

Mr. *Thomas Bailey.*

Thomas Bailey, called in and examined.

(*Chairman.*) In what situation are you serving?—I am clerk to the fellowship of pilots of Deal, and the oldest one on the station.

How long have you been on that station?—I have been 54 years a pilot.

(*Captain Fisher.*) Where in your opinion would be the best place to establish a harbour of refuge for the trade generally, outward and homeward bound; this harbour to be accessible at all times of tide, for men-of-war, armed steamers, and merchant-vessels of the largest dimensions, between the North Foreland and Portsmouth?—From what I have seen and observed, I must prefer the Downs.

(*Chairman.*) Do you mean the Great or the Small Downs?—I mean the Small Downs, though both might be included.

(*Captain Fisher.*) Are you of opinion that ships of the description already stated,

Mr. *Thomas Bailey.*
16th May, 1844.

seeking shelter in the place you propose from storms or for protection from the enemy, could proceed on their voyages outward or homeward bound, as the case might be, in all winds and all weathers?—The outlet to the northward of the Brake may be considered as having shallow water, and they could not pass through it at all times of tide.

Supposing a ship to break from her anchors in the situation you propose in the Small Downs, at any time of tide between half-flood and half-ebb by the stream, would she not find falling water both at Ramsgate Harbour and the passages leading out to the northward of the anchorage you propose?—She would find falling water.

What depth of water would she find in passing out at the time stated in either of those places?—I think that she would find about 16 or 17 feet water.

Would she find that water even from the situation of the buoy of the Fairway, which, I believe, is three miles from either of the other places above stated?—From two hours before till two hours after high water she would.

Supposing a harbour of refuge were constructed anywhere between the North Foreland and Dungeness, from what situation do you consider vessels outward bound, detained by stress of weather, would make their passage down Channel?—In my opinion the best situation would be Dover.

Should you feel any difficulty, or any objection, to taking a vessel into a harbour constructed at Dover, from your knowledge of its anchoring ground?—No.

(*Sir Howard Douglas.*) Supposing Dover Bay to be enclosed by a breakwater, how many entrances would you make, and where would you place them?—I should have two entrances; one as far to the westward as I could have it for the convenience and safety of the ships; and I should also have one to the eastward.

(*Chairman.*) In speaking of an eastward entrance, you mean it to be in a position where you would have the least cross tide?—Yes, I do; as it would be most safe for the navigation of ships.

(*Sir W. Symonds.*) Where would you drop your anchor in coming in with a south westerly gale?—It depends on the situation of the shipping previously arrived.

Where is the best anchorage?—The best anchorage is opposite St. James' Church in the valley, where the bottom is inclinable to a sort of clay mixed with chalk.

What is the ground further to the eastward?—I cannot speak to that.

(*Sir Howard Douglas.*) Would you under any circumstances of wind or time hesitate in taking a vessel into the projected harbour through the entrances you have suggested?—No.

(*Captain Fisher.*) Would vessels in your opinion, making sail from a harbour constructed in Dover Bay make their passage down Channel under circumstances when they could not from a harbour constructed to the eastward of Dungeness?—Yes.

(*Chairman.*) Are you a Deal man?—I was born at Deal, and now reside there.

[*The Witness withdrew.*]

John Barber Thornton, called in and examined.

Mr. *John Barber Thornton.*

(*Chairman.*) What are you?—A Cinque Ports pilot.

Where do you reside?—At Deal.

Are you native of Deal?—No; I am a Dover man.

If you were called on to construct a harbour for men-of-war to protect the trade, and at the same time for the accommodation of merchant-vessels, where between the North Foreland and Portsmouth would you have it?—Under the Brake.

The harbour we are speaking of is intended to be accessible at all times of tide, and in all weathers, night or day, for large ships?—The Brake would be accessible at all times of tide at the southern extremity.

What you mean to say is that you would have a work run out along the Brake Sand?—Yes.

What is the general depth of water under the Brake at low-water spring-tides?—The regular soundings, commencing from the South Brake Buoy direct in shore to Sandown Castle are from 7 to 3 fathoms.

Going further northward, what is the depth?—In a line with the first battery wall you have from 6½ to 3 fathoms.

Do you bear in mind that the question as to a harbour of refuge was intended to mean a station for steam vessels-of-war to give protection to the trade of the Channel, and do you think the place you have named the most eligible situation for such a harbour?—I do.

You think the place you have named lying more in the fairway for the protection of the Channel than any other?—I do.

(*Sir Henry Pelly.*) Supposing a breakwater to be erected from Sandown Castle to the eastward, and another breakwater laid across towards the south buoy of the Brake on any portion of the line which would give additional shelter to all vessels lying therein, would not that make a highly improved harbour?—Yes; I think it would.

Could there be one any better?—That is the view I have already taken of it.

You were asked whether steam-vessels lying there could protect the Channel; you do not mean to say that steamers lying near Sandown Castle could protect Dover and Folkestone?—No.

Mr. *John Barber Thornton.*

16th May, 1844.

All that you meant to say was that they would be a protection to the trade congregated in the Downs, but not to the Channel?—Yes.

(*Lieut.-Colonel Alderson.*) Do you not consider that a breakwater, as before stated, constructed on a portion of the line between Sandown Castle and the South Brake Buoy without any breakwater on the Brake itself, would render the Small Downs a greatly improved advantage?—Yes; but not so good an anchorage as if a breakwater were constructed along the Brake itself.

(*Sir Howard Douglas.*) If the Small Downs were converted into a harbour by breakwaters, would it be accessible under all circumstances of wind and weather, affording facility and safety of ingress and egress?—No.

(*Admiral Dundas.*) In the event of war it would be necessary to have a harbour on the coast of Kent, as a rendezvous for war steamers to be sheltered from all winds and weathers to be constantly ready to slip out at a moment's notice for the protection of the trade and the coast, and to combine those objects with that of being a harbour of refuge accessible at all times of tide, and in all weathers, night or day; at what spot on the coast of Kent from the North Foreland to Beachy Head would you say such a harbour ought to be constructed?—I should say at Dungeness.

In a gale of wind at S.W., is it your opinion that a powerful steam-vessel could get down from Dover to Dungeness?—I have seen many instances of fine steam-vessels putting back to the Downs, and men-of-war steamers could not get down in extreme cases.

(*Sir Henry Pelly.*) Does not Dungeness at present afford shelter for men-of-war steamers to lie to the eastward when the wind is westerly, and to lie to the westward when the wind is easterly without any artificial works?—The East Bay affords very good shelter with the wind from N.W. to S.S.W., and the West Bay from N. to E.; but if there is any southing of east in the wind, there is no shelter in either Bay.

(*Chairman.*) Dungeness having already naturally such extensive accommodation, would you, if a sum of money were laid down for a harbour of refuge, expend it there, or where there is less accommodation?—If I had got the money, I should go to the Brake Channel.

But I am now speaking of the westward?—Then I should go to Dungeness, notwithstanding the present accommodation there.

(*Captain Fisher.*) Is it your opinion that ships of the description, given you in a former question, seeking shelter in the harbour you propose inside the Brake from storms, or protection from the enemy, could proceed on their voyages outward or homeward, as the case might be, in all winds and in all weathers?—No.

Is it your opinion that vessels making sail from your proposed harbour under the Brake, and the proposed one at Dungeness, could make their passages down Channel under all circumstances when they could from a harbour constructed in Dover Roads?—From a harbour under the Brake they could as well as from Dover, but they could not from Dungeness.

Could vessels under all circumstance make their passages down Channel from either of the harbours you propose under the Brake or under Dungeness when they could from a harbour at Dover?—No.

(*Chairman.*) Supposing the entrance to a harbour at Dover to be direct south, could a vessel get out of that harbour with a strong S.S.E. wind?—No.

Looking at the plan before you, which of the entrances would you prefer?—The most westerly one.

(*Admiral Dundas.*) Would it not be better to have the entrance more to the southward, when facilities could be given for ships to be tugged out?—No.

What are the prevailing winds on this part of the coast?—South-westerly winds, and there is most sea with southerly winds.

Supposing a gale of wind from the south, would you break a ship from her anchor to go down Channel?—I would not with the wind at south.

Would you, in constructing a new harbour, prefer a spot like Dover when there are already facilities for the repair of ships in distress, or would you lay out money in so wild an anchorage as Dungeness, bearing in mind that the harbour would be constructed for steamers-of-war as well as merchant-ships?—I should prefer Dover, taking into consideration the facilities for repairs and so forth.

(*Mr. Walker.*) What is your objection to Dover, supposing you to have any as compared with any other place?—Its being so much exposed to heavy seas in S.W. gales; and I think it would not be an easy roadsted for ships at anchor.

(*Chairman.*) Do you think an entrance 700 feet wide would admit of the heavy sea you speak of?—Of course not, there would not be so much sea as there is now; but still the sea would strike against this harbour when formed with as much violence as now, which would come through this large space of 700 feet.

Do you think a narrower space would be fit for navigation?—A narrower space would cause less sea within the harbour; but the entrance could not be too wide for the purpose of navigation.

(*Mr. Walker.*) Looking at the objection to a very wide entrance by its admitting of heavy seas, and to the objection to a narrow entrance by difficulty of access and egress, what on the whole do you consider a sufficient width?—I should consider 500 feet plenty.

Would you prefer an entrance to the southward for ships coming up Channel?—I should prefer a S.W. entrance. I consider two entrances would be necessary. One to

get egress with outward bound ships, and another to get egress with homeward bound ships.

Mr. *John Barber Thornton.*

16th May, 1844.

(*Sir William Symonds.*) I wish to know what you think of the holding-ground?—It is very good opposite the church in the valley; but in other places it is hard.

From the opening which you recommend, would not the best ground be open to the wind?—It would if you were to run nothing out from the main shore.

[*Mr. Wright,* resident acting engineer of the South-eastern Railway Company, attended to produce a model corresponding with Mr. Cubitt's proposed timber caisson or breakwater, which is the same as is shown in the drawing attached to the evidence taken before the Committee on Shipwrecks in the House of Commons.]

(*Chairman.*) Have you anything to offer in explanation with respect to the model?—Nothing whatever.

[*The Witness withdrew.*]

Commander *Mercer,* R.N., called in and examined.

(*Chairman.*) You are superintendent of the Packet Service at Dover?—I am.

How long have you been in that situation?—Three years in August next.

Has your attention been much directed to the consideration of harbours on this part of the coast?—Not much.

Are you prepared to say where you would consider the best situation for the construction of a harbour of refuge, in which a squadron of war-steamers might watch for the protection of the trade, such harbour to be intended at the same time for the convenience of merchant-vessels, to be made somewhere between the North Foreland and Dungeness?—I am decidedly of opinion Dover Bay would be the best situation for such a harbour.

Do you know enough of Dover to speak of the anchorage in the Bay?—Yes; from the constant information I receive from the commanders of the packets, and having long lived in the neighbourhood.

What do you understand to be the nature of the bottom?—To the westward of the Castle Jetty the holding-ground is considered to be fair, and in the centre of the Bay it is supposed to be tolerable.

Are you acquainted with the coast further to the southward?—I have been at Dungeness, but I am not sufficiently acquainted with the soundings to give an opinion as to its eligibility as far as the soundings are concerned.

(*Sir Henry Pelly.*) Have vessels which have been obliged to anchor in Dover Bay, when unable to get into the harbour, driven from their anchors?—They have driven, from not having been supplied with proper ground tackling.

[*The Witness withdrew.*]

Commander *David Peat,* R.N., called in and examined.

Commander *David Peat,* R.N.

(*Chairman.*) Are you in command of the Coast Guard on this part of the coast?—I am.

Where do you reside?—At Folkestone.

Have you given much attention to the drift of the shingle, and what is the result of your observations?—I have not given the subject any particular attention, but it has come under my observation, and I have found its general movement is from west to east, and also that the tide seems to have no effect on the shingle, it being the gales alone that move it. I have noticed, that in the mouths of harbours, wherever there is an eddy of water or stillness, where the action of the sea has ceased to act on the shingle, there it rested. I have known at the mouth of a harbour, in one tide, from 100 to 500 tons to accumulate in one gale. This I have noticed at Dover, and also at Folkestone; and very lately, at the harbour of the latter place, sometimes 200 men were required every tide to keep clear the mouth of the harbour during a southerly gale.

If you were called upon to say which would be the best position between the North Foreland and Portsmouth for a harbour for a squadron of steamers to be in time of war, for the protection of the trade of the Channel, and at the same time to serve as a harbour of refuge for the trade, what part along this whole coast would you propose?—If I were confined to one particular point, I must say Dungeness; but if two points, I should select Dover and Beachy Head.

Might not the construction of a harbour or breakwater in the East Bay of Dungeness have a tendency to change the usual course of the tide, and by that means counteract the natural operation by which this projecting point of beach is lengthened out?—The shore is advancing there at present; but a breakwater out at a considerable distance, perhaps towards the Swallow Bank, might have a tendency to cause a greater run of the tide between the shore and the breakwater.

Before steam was in use it was felt that an artificial harbour would be very convenient; but do you think the present anchorage is a secure and excellent station for a steam squadron, as it could move with great facility from one side to the other without any breakwater?—Yes; but there are eight points in the compass at which there would be no protection for steamers on either side of the Bay, and that would be the only thing necessary to find protection against.

Commr. *David Peat*, R.N.

16th May, 1844.

But the necessity would not exist in the same degree at the present time, when there are steamers?—Not quite.

If a steam squadron were stationed at Dungeness, it would give protection, of course, to merchant-vessels congregated there?—Yes,

Is ague prevalent on the flat lands at Dungeness?—The very point is salubrious, but, curiously enough, on either side of the Point, inland, it does prevail.

Is there a good supply of fresh water there?—There is; but I am not able to say to what extent, or whether a large reservoir or excavations might not supply it to an extent. Near to the Point good and sweet water is to be had.

Do you know enough of the locality to be able to say where stone could be procured in the neighbourhood, supposing a breakwater to be made towards the point of Dungeness?—It would require to be procured from either Fairlight, Hythe, or Folkestone. At the latter place there is a sea-wall, being built of excellent stone procured in the neighbourhood.

(*Sir Howard Douglas.*) At what distance is Fairlight from the point of Dungeness?—About 10 miles,

Could not steam-vessels pass on either side of the Point, to the westward of the Head, in the case of an easterly wind, or the reverse way in the case of a westerly wind?—Certainly, as long as the steamer could make headway.

Do you think that the invention of steam, by enabling steam-vessels to pass from side to side, affords them a better anchorage than was available to sailing-vessels during the war?—Yes, I do.

You specified Dover as a place for a harbour of refuge, in the event of two being constructed, of what extent should you imagine such a harbour ought to be?—I fancied it should extend from the South Foreland to Shakspeare's Cliff.

To render the harbour easy of access, where would you propose to have entrances?—I should say not facing the S.W., because you would have a heavy sea rolling in. One good entrance to the south would prevent a heavy sea entering, because it would only be from the opposite coast, and consequently a short sea.

Do you think a southern entrance would be easy of access at any time, and give a sufficient command of anchorage?—Yes, I do.

(*Captain Washington.*) What should you consider a sufficient width?—300 yards.

Where do you propose another entrance?—To the eastward.

(*Chairman.*) Supposing a ship to be coming in in a heavy gale of wind, and the entrance placed in the centre of the harbour, when she runs to leeward so much, would she get in as easily as with the entrance placed more to the westward?—Certainly not; but unless a vessel was completely unmanageable, 300 yards would surely be sufficient to drive her in within the protection of the pier.

Looking at the entrances on the plan before you, supposing a vessel to come in at the southern entrance in a heavy gale of wind, she must take advantage only of the lower part of the harbour, and cannot shoot up to the windward part to take her anchorage, if so would a southern entrance give a fair command in entering the harbour?—Certainly; it would allow her to have the whole drift of the harbour, and the south-west gale with her.

If a ship were to enter with the wind blowing down the harbour, could she have the choice of the harbour for an anchorage?—Entering at the middle entrance, she would not have the advantage of the weather part of the harbour.

(*Admiral Dundas.*) Bearing in mind that the one harbour to be constructed is to answer warlike purposes, as well as to afford refuge for merchant-vessels, would you, in constructing it, prefer a spot like Dover, where there is already facility for repairing ships and steamers, and other accommodation for vessels in distress, or would you lay out money in so wild an anchorage as Dungeness?—The protection would be greater at Dover, and the facilities for repairing ships would have to be created at Dungeness.

If it were required to embark an army suddenly, could it be done with the greatest celerity from a refuge harbour at Dover or Dungeness?—At Dover, under the present circumstances, certainly.

In a gale of wind at S.W., could a powerful steamer get down from Dover to Dungeness?—I have seen such a gale in which she could not. In such gales as happen about once in six years she could not.

(*Sir Henry Pelly.*) Do not merchant-vessels congregate in large numbers in the Downs?—Yes, large fleets congregate in the Downs; and my reason for wishing a harbour of refuge at Dungeness is to save them running so far.

Supposing there is no harbour of refuge between the North Foreland and Dungeness, where must vessels then congregate for safety. Do you think that they would, in war time, be able to get down to Dungeness without being attacked by an enemy?—Certainly; a harbour of refuge, with war-steamers at Dover, and another at Beachy Head, would afford greater protection.

Should you think a capacious harbour of refuge at Dover alone would take in all those vessels which now congregate in the Downs, and if so made, whether it would not be a better place for a harbour of refuge than the Downs?—It is my opinion that Dover would be a better place than the Downs. Concerning the first part of your question, as to whether a capacious harbour at Dover only would be sufficient, within two months I have noticed about 100 sail of vessels pass to the westward. In two days a beating wind came on; they beat down till it came on to blow, when the whole of this 100 sail of vessels ran back

Commr. *David Peat*, R.N.. — 16th May, 1844.

to the Downs; therefore I calculated that these 100 vessels, supposing they were to commence beating down again, would have lost much time, which they would have saved had there been a harbour to shelter them at Dungeness.

On the whole, which do you think the best situation for establishing a harbour of refuge, taking all the circumstances into consideration?—Dungeness.

Are you aware of the course from a harbour constructed at Dover to round the point of Dungeness?—W. and by S.

(*Captain Fisher.*) Would or would not vessels, in your opinion, making sail from a harbour constructed at Dover, make their passages down Channel under circumstances when they could not from a harbour at the East Bay of Dungeness?—In certain winds Dover would have the advantage.

(*Sir William Symonds.*) With your principal entrance to the southward, as I believe you have proposed, how would vessels outward bound be enabled to leave that harbour with a S.E. wind, that being favourable for them to proceed down Channel?—With an entrance of 300 yards wide any vessel, by shaving the weather pier or the eastward pier close, if not in a heavy gale of wind, would shoot out clear of the westward pier.

Could she slip from her anchorage in any part of the harbour in a S.S.E. wind?—To the westward part of the harbour she could not, but to the eastward she might.

You have been a long time in the navy, and in active service; if, coming in a man-of-war, knowing the situation of the Downs, would you be inclined to run into Dover projected harbour, formed as you see it on the plan, in order to bring up in a very heavy gale of wind, the harbour being embarrassed with a large number of merchant-vessels, if you knew that at least one-half of that harbour has a bottom of chalk, not holding-ground, and there being only 22 feet water in the centre of the harbour?—Under the circumstances stated, I would certainly prefer running and anchoring in the Downs, unless the gale was one which was right through the Downs; then, excepting with a very good pilot, I would run to Margate Roads.

(*Captain Washington.*) In running a ship into such a harbour, with the choice of anchoring in seven or four fathoms, which would you anchor in?—I should prefer the seven fathoms.

(*Sir William Symonds.*) Would you anchor anywhere if the ground were bad?—Not by choice.

(*Chairman.*) Do you know anything of the soundings in Dover Bay?—I know a little about them.

What is the nature of the ground?—It is considered pretty good holding-ground.

(*Admiral Dundas.*) If you anchor in 6 fathoms water with the wind at S.W., would you not be driving up hill?—Yes.

(*Sir Henry Pelly.*) Now supposing a harbour to be constructed on the east side of Dungeness, could you, with the wind at S.S.E., lay out so as to clear the Ness by it?—I think if the breakwater was a considerable distance from the shore, that with a S.S.E. wind I could still round the Ness Point; but in going out of Dover Harbour, there appears to be a point or two in the compass in favour of Dover.

(*Mr. Walker.*) You stated that you would prefer two harbours to one; now, you know Dungeness is a harbour of refuge as it is, excepting certain winds (such as when to the S. of E.), and taking Dungeness as it is, and also Dover as it is, supposing a large sum of money about to be laid out, and at one place only, would you, under all the circumstances referring to the general question which has been put to you, prefer laying out that money at Dungeness or Dover?—I should say Dungeness.

Supposing the harbour to be for armed steamers to be constantly on the look out for protecting the coast, would you prefer laying out the money at Dover or Dungeness?—There is greater protection at Dover, which would have to be created at Dungeness. If only one harbour were to be constructed, Dungeness would be something like in the centre, whereas a harbour at Dover would be at one end, the war-steamers would be ready to keep at Dungeness E. or W.; but if the only harbour were at Dover in S.W. gales, all the steamers would go there for shelter, and there would be no protection for trading vessels at Beachy Head.

In the event of war, which do you consider the best stations on this part of the coast for steam ships-of-war to watch the cruisers of the enemy in their attacks upon our traders?—I should say about Dover and Beachy Head.

(*Admiral Dundas.*) From what quarter have you the most severe and most frequent gales in the Channel?—From the S.W.

Then, would you construct your breakwater at Beachy Head, at the W. or the E. side of the Head?—For protection from S.W. gales, I should say to the east of the Head.

You prefer, as well as a breakwater to give shelter to the cruisers about Beachy Head, a harbour at Dover combining the purposes of commerce and war together?—Yes.

Do you know anything of Newhaven?—Not much.

What kind of holding-ground is there in Eastbourne Bay?—There is good holding-ground there.

Do you know anything about the Sovereign Shoal?—I know something about it, but I cannot describe it distinctly.

Is there plenty of room between the Sovereign Shoal and the shore for working the largest ship through?—I think there is not.

Commr. *David Peat*, R.N.

16th May, 1844.

With Beachy Head light, and the light to be placed on the proposed breakwater, would you have any hesitation in running a ship in there in a S.W. gale?—I should have no hesitation in doing so, and I would by that means save running 70 miles to the Downs.

In the event of a war, Beachy Head is the most prominent point for cruizers?—I think so.

(*Admiral Dundas.*) Supposing it was determined upon to erect a breakwater near the east side of Beachy Head, what stone is there thereabout to erect it?—There is nothing but chalk in that neighbourhood.

How would it stand the sea?—Very well, and it seems a compact fair good stone.

[*The Witness withdrew.*]

Lieut. *Matthew Coombe*, R.N.

Lieutenant *Matthew Coombe*, R.N. called in and examined.

(*Chairman.*) In what situation are you?—I am a lieutenant in the Royal Navy.

How are you employed?—On the Coast Guard Station, No. 2 battery, East Bay of Dungeness.

How long have you been employed there?—Six years and four months.

During that time how many vessels have you seen driven ashore in the East Bay of Dungeness?—During that period I have seen 12 or 13.

Have you given much of your attention to the construction of any breakwater there?—I have.

What is the result of your observations?—I have always thought that there ought to be shelter for shipping in the East Bay.

Do you not think that the bay on either side, east and west, is a good and safe anchorage in its present state for a steam squadron to be stationed there, having the power on a change of wind to get up their steam and proceed to either side, without any breakwater being constructed?—No, I do not.

Is not the West Bay a good anchorage, and much used?—Yes, in east winds, but the East Bay has the best anchorage.

Is not Dungeness a good anchorage for steam-vessels?—Yes, as the wind may be.

Do you know much of the coast between the North Foreland and Portsmouth?—I have not been in practice lately, but I formerly knew the coast; I commanded the "Watchful" cutter for two years, a tender to Captain M'Culloch, in the Blockade Coast Guard Service, and then I had a great deal of practice from the Downs to Beachy Head, but more especially about Dungeness.

If you were called upon to fix on a place between the North Foreland and Portsmouth for a harbour to be constructed, to accommodate war-steamers to look out on the enemy, to afford protection to the trade in the Channel, and also as a port of refuge for merchant-vessels, what spot would you select?—If one harbour were to be constructed, I should select the East Bay of Dungeness; but if two were to be made, I should choose Dover also.

In your cruizes did you not consider Beachy Head an important position?—It is great in importance, but I never liked Eastbourne Bay.

What is your objection to it?—The anchorage is not good.

What is the nature of it?—There is a good deal of rock and foul ground about it.

From experience, did you find it so?—Yes.

Supposing the ground to be good, should you think the Royal Sovereign Shoal would be any obstruction to having a breakwater erected at Eastbourne?—None whatever.

Is Dungeness an aguish place?—Yes it is.

Have you had many of your men attacked with the ague since you have been there?—Not many; close to the lighthouse it is not so prevalent.

(*Sir William Symonds.*) Is Dungeness much frequented by vessels bound up and down Channel?—It has been very much lately.

How many vessels have you seen at any one time under the Ness?—I have counted upwards of 300.

Do foreign as well as English merchant-vessels take pilots when bound to the eastward from Dungeness or from Dunkirk?—They have them off here.

When the sea is violent enough to wreck vessels on the coast, is it so heavy as to break them up?—No.

If a large breakwater were made 2 miles long in the situation shown you on this chart, would it be of advantage to that shipping?—It would be a safe anchorage for all shipping.

Do you see the opposite coast from the Ness?—Yes, we do.

If in time of war such a breakwater were formed with proper defences, do you not consider that it would be of great importance, in the event of the enemy making a descent upon that part of the coast?—Yes.

(*The Chairman.*) But under the present circumstances, as steam-vessels would be able to maintain their stations, the same danger would not exist?—Not to such an extent.

(*Sir W. Symonds.*) How does the tide set from Dungeness?—From the point to the Foreland.

How does the tide run from the point towards the coast of France?—There is an eddy to the S.E.

As an old sailor, and having lived long at Dungeness, have you ever experienced

a moment when a merchant-man could not, by going out of the lee side of the proposed breakwater, stand out sufficiently long to make a tack and weather the Ness, with the wind from S.S.W. blowing hard?—No. Lieut. *Matthew Coombe*, R.N.

(*Chairman.*) Supposing, at the time you are speaking, a large convoy getting under weigh to proceed outward bound, do you think a merchant-ship could make that tack, the tack you are describing?—Standing on the starboard tack they could; but with the flood-tide I should doubt whether they would be able to do so. 16th May, 1844.

(*Admiral Dundas.*) In general could a powerful steamer get from Dover to Dungeness in south-westerly gale?—Generally it could.

Bearing in mind that the spot to be selected for a harbour is for warlike purposes as well as a harbour of refuge, would you prefer a spot like Dover, where there is already facility for repairing ships and steamers, and other accommodation for vessels in distress, or lay out money in so wild an anchorage as Dungeness?—I should at Dungeness.

If it were required to embark an army suddenly, could it be done with the greatest celerity from Dover or Dungeness?—From Dover.

(*Captain Fisher.*) During the time that you have been resident on this coast, have you ever observed that vessels could sail and round the Ness when they would not be able to do so from the harbour you propose at Dungeness?—No.

Could vessels with a strong wind from S.S.E. sail from your proposed harbour of refuge without working to windward?—They would require to make one board out.

From your knowledge of the situation of Dover Roads could vessels with a S.S.E. wind round Dungeness without making one board, which you say would be necessary from a harbour at Dungeness?—Yes.

(*Chairman.*) You say that 300 sail have sheltered under Dungeness at one time, you mean to give that as a proof of the general confidence of the trade in the present anchorage?—Yes, and they are becoming more confident every day.

(*Lieut.-Col. Colquhoun.*) Where, in the time of war, do you think that steam-ships should be stationed for the defence of the coast?—From Dungeness to Beachy Head.

(*Capt. Washington.*) You have stated that the eddy-tide off Dungeness sets S.E. towards the coast of France; how far does it extend off shore, and how long does it run?—It begins about five miles off, and sets towards the coast of France.

(*Mr. Walker.*) You stated that you have known from 12 to 13 vessels to have driven ashore in the East Bay while you have been on that station; were any of them wrecked?—Two of them were.

Were they total wrecks?—They were so far considered to be so as to be sold for the benefit of the underwriters.

What was the amount of damage done to the other 11?—The greatest damage was done to the "Beulah," which started a plank from off her garboard, after being on shore for eight days, with an easterly wind blowing strong.

[*The Witness withdrew.*]

Mr. *John Iron*, called in and examined. Mr. *John Iron.*

(*Chairman.*) What are you?—I am Harbour Master at Dover.

How long have you been in that situation?—Twelve years.

Were you bred to the sea, or what was your former occupation?—I have been to sea 55 years.

In what situation?—I served my time in the merchant service, after which I was employed in the hired armed vessels in his Majesty's service till 1807, when I was a Cinque Ports pilot till 1832.

It is your duty to be almost constantly at the pier-head of this place?—Yes, when ships are coming in or going out.

What are the winds which bring the greatest accumulation of beach towards the harbour's mouth?—The winds from W.S.W. to S.W.

Is there much accumulation at present about Shakspear's Cliff?—Round the point of Shakspear's Cliff there is but little.

But if a gale were to come on from W.S.W., would the shingle appear about the harbour?—It would, but the shingle has been stopped by the late excavations connected with the railway-works, which prevented the shingle from coming round Shakspear's Cliff.

But a south-westerly gale would bring it to the harbour again?—Yes.

Does any shingle gather round the harbour when the wind blows from the East?—None.

How long has it been blowing from the eastward?—About three weeks.

There appears at the present time, by the eastern pier, to be a considerable quantity of shingle; is that always there?—No, it is within the last ten weeks that it has been driven away by the sluices; and the westerly winds have taken it to the back of the East Pier.

When the entrance to the harbour is clear of shingle at spring-tides, for how many hours would there be ten feet water at the rising and the ebbing of the tide?—About five hours on the average.

Mr. *John Iron.*

16th May, 1844.

What is the quality of the bottom in Dover Bay?—There is gravel, sand, and clay in different parts of the bay.

How would you describe the holding-ground, is it good, bad, or indifferent?—It is very good in some parts, and in others indifferent. About the Valley it is very good, but not so good in other parts.

Do fishermen trawl in the bay?—There is no trawling-ground there.

Are there rocks in the bay?—None, except close in shore.

Have you ever known any vessel ride out the gale with the wind on shore?—I do not recollect any particular circumstance; but I believe about 55 years ago a collier did so, without starting.

Are you generally in attendance when vessels are standing in for the port in bad weather?—Generally.

Is it very frequent in such weathers that vessels seeming desirous to take refuge in Dover Harbour are deterred from entering on account of the shingle?—We haul down the flag if it is not prudent for them to enter, sometimes on account of the bar, and at other times on account of the sea; and if there is a heavy bar, we do not hoist the flag, indicating that vessels may enter.

Supposing an artificial harbour to be constructed, enclosing Dover Bay, should you have any doubt as to the holding-ground?—I should have no doubt but that ships would hold in any weather.

Do you consider that vessels wishing to take shelter in south-westerly gales would prefer running to the proposed harbour in Dover Bay, or running to the Downs?—I should think they would prefer the harbour of refuge.

Has there ever been, at any time within your knowledge, any boring of the bay, to know what it is?—Not in the bay, but just in the harbour; and outside of this I cannot give any information; but there is an engineer who can.

Can you state the number of vessels that have entered this harbour in any one year on the average?—In 1834, 1,067 coasters and British and foreign vessels, not including fishing-vessels; and in the same year 1,373 steam-packets and passage-vessels. In 1842, there were 1,298 coasters and British and foreign vessels, exclusive of fishermen; and 1,509 steam-packets and passage-vessels. In 1843, 1,286 coasters and British and foreign vessels; and 1,612 steam-packets and passage-vessels.

Supposing an artificial harbour to surround the present harbour, would it be great accommodation if the present harbour were converted into a wet-dock?—It would, for loading and unloading.

What is the whole extent of the wharfage you have round your basins, supposing your harbour to be shut in as a wet-dock?—6,559 feet, as the harbour stands at present, independent of the improvements about to be made.

If there were an artificial harbour formed, and an enclosure to take place, would you make any suggestions as to getting rid of the silt and the back-water?—It would require to be carried out to the westward of the artificial harbour under the street, and I do not know that there would be any difficulty in doing so.

Supposing a breakwater to be placed in Dover Bay, according to the plan which is now shown to you (*Mr. William Cubitt's Plan, laid before the Shipwreck Committee,* 1843, *Report, page* 261), do you think an entrance at each end would be desirable?—I do not think that would be desirable at all; I think the beach would come in at the western entrance.

Do you think that the beach would pass through and lodge?—I think it would come into the bay and fill it up, and there would be no means of getting it out.

You do not think it would be carried through the harbour?—No.

Looking at the plan now placed before you, showing three different lines of breakwater, which of the three entrances described would you prefer?—I should prefer the outer line of breakwater, and the southern entrance.

If an entrance were placed where you point out, and ships were coming in with a heavy gale of wind, would it not prevent their taking advantage of any other part of the harbour, excepting the eastern part of it?—There is no doubt but that it would.

What is your objection to the western entrance?—I think there is more chance of shingle going in than at the southern.

But supposing there was no risk of the shingle going in at all, then which entrance would you prefer?—Then I should prefer the western.

Do you believe, from your experience of the shingle, that in a depth of seven fathoms water, at low-water spring-tides, any shingle would get there?—I think in the course of years it might. I have an idea that if there is any light substance to come along shore, a gale would bring it over, if it were chalk.

Looking at the plan, with the breakwater coming out from Cheeseman's Head to the extent shown on the plan, would not that carry the shingle into deep water?—I believe that the shingle would fill up there in the angle, from Cheeseman's Head to the elbow of the breakwater, and would then go on till it came to the western entrance, and then turn into the harbour.

Would there not be the same effect were the entrance at the south?—There is no doubt of it, in the course of time.

Then you do not believe that the action of the shingle is confined between high and low-water mark?—I do.

Then in that case how can it approach the entrances in a depth of seven fathoms?—It will make shallow water as it accumulates.

Do you think, in a depth of seven fathoms, that will be the case?—I think it will.

How long will it take?—It depends on whether there is any means taken, such as jetties to stop it.

You do not believe that that kind of breakwater, throwing the beach into deep water, would prevent its accumulating?—No, I do not.

Supposing a ship to be coming up Channel, with the wind at W.S.W., which entrance would you consider the best to be left open for her to enter?—In a harbour of this extent I would have one as soon as the other.

If you were in charge of a ship coming in, which of these entrances would you consider as giving the greatest command?—The weathermost one.

(*Admiral Dundas.*) Supposing the harbour to be full of shipping, and a ship coming in from the S.W. in a gale, would she deaden her way quicker by coming in at the middle approach than in the south-western one?—In the middle or south you may do what you like with your ship.

(*Chairman.*) Supposing a ship to be coming in with a heavy gale, does that not unavoidably oblige her to go into the lee part of the harbour?—Yes.

Then a multitude of ships, if coming in under the same circumstances, would all be driven into that corner?—They would all be obliged to take the lee part of the harbour.

What breadth would you have between the pier-heads for an entrance?—Not less than 1000 feet.

For what purpose do you require so great a breadth?—In bad weather there would generally be a heavy sea before a harbour of this description, and there would also be a strong tide.

But would not a space of 700 feet be sufficient for any ship to shoot into that harbour?—No; with merchant-ships you are generally short-handed, and the sail is required to be got in.

Would you have a second entrance?—I do not see much utility in it.

If there were no other entrance than the one you propose, would not the harbour be likely to silt up?—As far as regards silting up, you would require another entrance; but it would not be necessary for the shipping.

Would not the second entrance afford greater facility in getting in and out?—I do not see that you could not get in almost as soon at entrance A 3 as at an eastern one.

Then to prevent accumulation of silt, you would have two entrances; but for the shipping only one?—Yes.

Then as you are apprehensive that the shingle would come into the harbour, you would rather have no harbour of refuge at all at Dover?—It is not for me to say whether we should have one or not; I was only speaking on the supposition that nothing could be done to the westward in the first place to prevent the shingle coming along the coast.

Something would certainly be done by the proposed extension of the pier from Cheeseman's Head?—That would certainly be of some effect.

(*Admiral Dundas.*) Supposing an entrance at S.W. to be made of 1000 feet in width, would there not be a heavy sea roll in?—Yes.

Would there be less sea with one at south?—Certainly.

Now a ship lying at the east side of the harbour, wanting to get out, must work up before she can do so if the wind was westerly?—Yes.

Then would not a small passage to the eastward be a good thing?—Yes, it might be of some benefit; but there is a heavy tide which runs direct in shore.

Supposing a ship gets under way with a westerly wind, a leading wind, bound to the eastward, would it not be a great convenience to her if there were a small entrance to enable her to get out at the entrance, and especially as her having a leading wind would prevent the tide having much effect upon her?—It would be of some benefit.

(*Sir Howard Douglas.*) Do you think, with all your experience, that this bay may be constructed into a harbour of refuge accessible at all times of tide and in all weathers?—I think it could.

(*Chairman.*) If you were called upon to give an opinion as to the best position between the North Foreland and Portsmouth for a rendezvous for war-steamers to protect the trade of the Channel, and at the same time to give shelter to ships navigating the Channel, on what spot between these two points would you fix?—Dover Bay.

Do you think that enclosing Dover Bay is desirable at a great cost of public money?—I think it the most desirable place between the two points named.

(*Sir Henry Pelly.*) You know the Downs pretty well?—Yes.

Supposing that an equally commodious harbour could there be made for the trade coming down from the river, would Dover or the Downs be the best situation?—Dover would be the most convenient for the trade.

(*Captain Fisher.*) With your knowledge of the anchorage in Dover Roads, would you have any hesitation in running a vessel for security into any harbour that might be constructed there?—Not in the least.

Would the entrance you prefer enable vessels to leave that harbour in winds the most to the southward that would allow outward bound ships to make their passage down Channel?—It would allow them to do so.

Without an entrance to the eastward, which you rather objected to, how would ships detained by stress of weather go to their destination even when the wind was fair?—I see no difficulty in the case of their doing so.

Mr. *John Iron.*

16th May, 1844.

With your knowledge of the coast, are you of opinion that vessels from a harbour constructed in Dover Roads could make their passage down Channel under extreme circumstances, when they might be prevented going to a harbour on the east side of Dungeness?—Yes.

Are you a native of Dover?—No; but I have resided there from a boy.

(*Sir W. Symonds.*) Supposinga fleet of merchant-men to becoming from the Thames, and prevented going down Channel by the prevalent westerly winds, such a fleet would, as things are, stop in the Downs; and if a harbour of refuge were constructed in the Downs, they would be able to take shelter in it; but supposing a harbour to be constructed at Dover, how would ships such as I have described reach that harbour?—In one tide they would be able to reach a harbour of refuge constructed at Dover, if it did not blow too hard.

Supposing it to blow a strong breeze of wind, could they do so?—If I found a strong wind at S.W., in coming down the river, I should anchor in Margate Roads, where I should already have a good roadstead.

Of ships in the situation I have described, do the greater number stop in Margate Roads or come to the Downs?—With a S.W. wind, the greater number remain in Margate Roads; but with westerly winds, the greater number come to the Downs.

They could not get round the Foreland with a strong S.W. wind?—No.

Do you consider, for a fleet of merchant-men coming down Channel with a S.W. wind, Dover is a better situation for their taking shelter than the Downs, if they could reach Dover?—They could not reach Dover in a gale of wind from S.W.

What is your opinion of Dungeness, in its present state, as a shelter for shipping?—It is an open roadstead in its present state.

Do you consider it at present a safe position for steamers to remain at?—Not with the wind at all points of the compass.

(*Mr. Walker.*) A good deal has been said with regard to the shingle in front of Dover harbour; I wish to ask you whether you consider the harbour has derived important benefit from the sluices of late years?—Great benefit.

When did they come into operation?—In the autumn of 1837.

Has the entrance to the harbour been nearly as much impeded by the shingle since that period as it was before?—Not at all; before, it was blocked up for seven or eight days at a time; but since, it has never been blocked up more than two or three days.

Has it ever been blocked up for two or three days at a time by the shingle alone since the sluices were opened?—It was blocked up for two or three days, but not from the bar alone, during the heavy gales of January and February, 1840.

When, after 1840, was it blocked up again?—We have not had it blocked up since for more than a day or so.

What do you conceive, from your previous knowledge of the harbour, would have been its state during the gales of January and February, 1840, if the sluices had not been in action?—It is likely it would have been stopped up for 14 days, and perhaps longer.

Do you consider that the shingle you have had since the great fall of chalk to the westward of Shakspeare's Cliff was shingle that was previously on the eastward of Shakspeare's Cliff?—Yes.

Then do you think that the chalk which has been removed into the sea by the railway works has prevented the shingle from coming from the westward?—I do not think any shingle from the other side of Shakspeare's Cliff has come this way since the operations of the Railway Company; and the excavations that have been thrown out into the sea have caused the chalk to come along the shore in gales of wind, and mix with the shingle, so that it has become cemented together, and rendered it more difficult of removal from the mouth of the harbour.

Have you had an opportunity of noticing the accumulations that have taken place to the westward of these projections of chalk in the sea between Folkestone and Dover?—I have not.

Am I correct in saying this, that if it were possible by some contrivance to fix all the shingle that lies between Shakspeare's Cliff and the mouth of the harbour, or to remove it, you would have no shingle at all in front of the harbour?—None; that is my opinion.

Do you think that all the shingle that annoys you travels between high and low-water mark?—I do; I think that no shingle travels below low-water mark.

If this is the case, will you explain to the Commissioners what you mean by saying that in the course of time the shingle would be likely to accumulate in front of the entrance of the proposed harbour of refuge, when that entrance is in a depth of six or seven fathoms at low water?—The shingle comes along shore until it meets the obstruction of the pier; there it falls down, and keeps extending out, and shallows the water as it keeps accumulating.

(*Chairman.*) What charges are ships liable to at Dover?—From 3*d.* a ton to 1½*d.*, and the difference depends on the commodity with which they are laden.

Are ships coming in for refuge liable to the same charges as are paid by those discharging cargoes?—I think so.

What distance is the shingle driven away by the sluices?—It depends on the lowness of the tide. At low tide, it will be taken 50 feet from the sluices.

Does the rock at the entrance of the harbour there obstruct it?—There is no rock there. All sluicing power after the water finds its level loses its effect.

Mr. *John Iron.*

16th May, 1844.

Are you of opinion that the harbour is capable of being improved?—Enlarging the present outer harbour, and making a gate-way 60 feet wide into the Pent, will be the means of admitting large steamers into the Pent, where they could not go in safety before.

(*Admiral Dundas.*) Are you at great expense in sluicing?—About 120*l.* a-year.

Would that expense be entirely saved if you had a harbour of refuge outside?—Yes; we would then have no occasion for sluicing.

(*Chairman.*) Could the sluicing power be applied in any other way for a useful purpose?—I do not think it could.

(*Sir Howard Douglas.*) In such a gale of wind at S.W. as merchant-ships could not break ground from the Downs to get to the proposed harbour of refuge at Dover, would that be a probable time for an enemy to make an attack?—I should think not.

And could not, with that wind, English war-steamers leave Dover for the protection of the trade with the most perfect ease?—Certainly they could.

The constructing of a harbour of refuge outside the present harbour would enable you to improve your inner harbour to a very great extent?—Yes, it would.

By deepening the present outer harbour by excavation?—We could deepen the whole of the present harbour.

Would the foundation of the present harbour allow you to do so?—Yes; it is chalk.

[*The Witness withdrew.*]

Mr. *William Basden*, attended at his own request.

Mr. *William Basden.*

(*Chairman.*) Are you residing at Dover?—Yes, I am; I have resided here for the last two years.

In what situation are you?—As purser of the Packet Service.

You have desired to see the Commission on some subject, what is it?—To present a small model.

Will you explain your object?—[*Witness here handed in a written explanation of his model.*]

(*Sir Howard Douglas.*) Have you any idea how long the wood would last?—If we may judge from the wreck of the "Royal George," it would last for a great many years; and even the rotting of the timber would be of little consequence.

[*The Witness withdrew.*]

Mr. *Luke Smithet*, R.N. called in and examined.

Mr. *Luke Smithet*, R.N.

(*Chairman.*) In what situation are you?—As commander of Her Majesty's steam-packet "Princess Alice."

How long have you been employed in the Packet Service?—I have been 22 years on this station.

Should you find it of great benefit to have an artificial harbour surrounding the present harbour of Dover?—I should, very much.

Putting aside the convenience you would feel on account of your own vessel being at this port, which, as an experienced man, would you consider the best place on this part of the coast for the construction of a harbour of refuge, to give protection to the trade in blowing weather, and also for a squadron of steam-vessels in time of war to render protection to the trade of the Channel, and to watch the motions of an enemy?—Dover Bay, in this point of the Channel, because it is nearer the opposite coast than any other place, and, in blowy weather, ships might approach and enter at all times by day or by night.

You would prefer Dover, and think it a more eligible place than the Downs for the purposes enumerated, and more preferable than any other part between the North Foreland and Portsmouth?—I consider it so for war purposes, as well as for the shelter of the trade in time of peace.

Dungeness having a good harbour at present on each side of it, is it your opinion that money would be more advantageously laid out on a harbour here than on one at Dungeness?—Yes, on account of Dungeness having two roadsteads, one in the East and one in the West Bay.

Is it your opinion that, having these natural advantages, money would be better expended elsewhere in providing a harbour?—Yes.

The plan now put before you represents three lines of breakwater in front of Dover; the first is in six fathoms, the second in seven fathoms, and the third on the outer edge of the seven fathoms; which of these three, in point of extent, would you prefer?—I would prefer the largest, as giving more general accommodation.

You see in these projected breakwaters three different entrances, marked A 1, A 2, and A 3, which would you prefer?—I consider A 3 the best for the centre entrance.

Supposing A 3 to be adopted, would not the benefit to the shipping be confined to the lower side of the anchorage?—Yes.

Will the entrance at A 3, always bearing in mind that we are supposing a gale of wind, give the greatest command of the anchorage?—It would.

Supposing a convoy of 100 sail to be coming for the harbour, would not this en-

Mr. *Luke Smithet.*

16th May, 1844.

trance at A 3 force them into the lower part of the harbour?—It would, and they would be safer there.

Would you approve of two entrances?—Yes.

What space between the pier-heads of entrance A 3 do you consider would be sufficient?—From 700 to 900 feet.

Of what breadth would you have the eastern entrance?—From 250 to 300 feet.

Have you any movement of the shingle at Dover?—A good deal.

Suppose you have an entrance at A 3, would you have any apprehension of the shingle getting in there?—No, I think it would not travel in deep water. I do not believe the shingle would come to A 3 entrance to as to affect the harbour.

(*Admiral Dundas.*) Would it not disturb the anchorage of the harbour to have an opening to the S.W.?—Very much; and it would also admit the shingle sooner into the harbour; and if it were admitted you would be unable to get it out.

Supposing a ship to be coming in before the wind at the S.W. entrance, must she not wind round to come through?—Yes.

Would she require more room to haul up to an anchorage than if she came in at the south-eastern entrance?—Yes.

With a gale at W.S.W., and a ship hauling round the western head of the S.E. entrance of the projected harbour, how would she lie up?—at N.W., and fetch into shelter.

(*Chairman.*) When you talk of a ship hauling up in a gale of wind, how can she lie up to get her anchorage?—At N.W., which would fetch her into shelter.

(*Captain Fisher.*) With your knowledge of the bottom of Dover Roads, would you have any hesitation in running in a vessel there which might be committed to your charge for security in very bad weather?—No.

Would the entrance you prefer enable vessels to leave the harbour in bad weather in such winds at the most southerly point that would permit them to make their passage down Channel?—I should think most vessels would be able to turn out with the wind right on shore. The reason is, there is little or no sea from S.E. and S.S.E. winds.

(*Chairman.*) Supposing vessels are entering this proposed harbour at No. 3 entrance, wishing to go to the inner harbour, would they fetch in?—No, they could not.

Taking any other entrance, would they?—Yes; at the western they would.

(*Admiral Dundas.*) In all weathers could a powerful steamer get from Dover to Dungeness?—There is not perhaps twice in a year that she would be prevented from starting.

Captain *Hamilton*, R.N.

The chairman here addressed Captain Hamilton, R.N., of Dover, who was present during the examination of last witness. You have heard the evidence which has been given by Captain Smithet?—Yes, and I approve of all that he has said.

[*The Witness withdrew.*]

Mr. *Richard Moull.*

Mr. *Richard Moull,* called in and examined.

(*Sir William Symonds.*) Are you a Dover pilot?—I am.

How long have you been acting in that capacity?—I have been 29 years a Cinque Ports pilot, and 7 years in the navy.

Are you a Dover man?—Yes, and was born there.

If a large and extensive harbour were to be created between Portsmouth and the North Foreland, to serve as a rendezvous for a squadron of war-steamers to protect the Channel, and as a harbour of refuge for the trade, where do you think would be the most desirable situation?—I know of no place to protect the shipping from all winds except such a harbour were to be carried round in Dover Bay on an extensive scale.

(*Sir Howard Douglas.*) How many entrances would you have for such a harbour, and where would you place them?—I should only propose two, one at the westward end (A 1), and an eastward one.

(*Admiral Dundas.*) What space would you required between the pier heads?—It should be at least a quarter of a mile. A ship entering at A 3, in a strong gale of wind could not possibly be brought up in time if she were even to let go both her anchors, because she would have to carry a great deal of canvass, on account of the rapidity of the cross tide, to give her way enough for entering the harbour.

Would she have more way going down before the wind and sea, or hauling up on the larboard tack?—Not so much, because she would have most of her canvass stowed, and the whole of it as soon as she passed the entrance of the harbour.

Would the harbour be more tranquil with an opening 1000 to the south-west than it would by being open to the southward only?—The harbour must be formed with an elbow, otherwise the sea will sweep into it.

But if there was a southward entrance, would no sea at all run from the west?—I should think there would be more.

How could there be more sea with a southward entrance than with a S.W. approach?—I should suppose, in forming the harbour, the mouth of it would lie to the westward, and not to the S.W.; and then so as to form an elbow coming out to the S.W.

Would the shingle come in from the westward?—The shingle has travelled beyond the skill of any one to form an opinion, from what I have seen. Mr. *Richard Moult.* 16th May, 1844.

Would not the shingle be more likely to come to the western entrance than if the opening was to the southward?—I should think not, provided that the inner pier was carried to the extent of the rocks. If it were carried into 7 fathoms water, I should think it impossible for the shingle to come in.

(*Sir William Symonds.*) What sort of holding-ground is there in Dover Bay?—Not very good.

(*Sir H. Pelly.*) From the knowledge you have of the anchorage-ground of the proposed harbour at Dover, would you have any objection to running a vessel into it for security in bad weather?—Not in the least, as regards the ground.

[*The Witness withdrew.*]

Lieutenant *B. Worthington*, of Dover, examined. Lieut. *B. Worthington.*

(*Chairman.*) Have you given much consideration to the subject of Dover Harbour?—I have given attention, and have written upon the subject. I was called upon to give evidence before a Committee of the House of Commons in 1836, and the Commission appointed by the Government, under the direction of Admiral Sir James Gordon, in 18 .

Supposing you were called upon to name an eligible spot for a harbour of refuge, between the Thames and Portsmouth, what would you name?—Supposing other sites equally eligible in point of situation, I should name Dover.

What is your opinion of the anchorage in Dover Bay?—The holding-ground is very good in Dover Roadstead; ships anchoring with St. James's church tower on with Old Park in the Valley, with the South Foreland Lights open, in from 10 to 14 fathoms water, scarcely better holding-ground is be found in the English Channel; the marks I have stated is a berth for large ships; small vessels usually anchor in the Bay, where the ground is compact sand, and in some parts chalk.

You have described one particular part with certain bearings, but what do you consider the general nature of the holding-ground?—No foul ground, and the whole of it good holding-ground; I confine this observation strictly to the limits of Dover Roadstead.

Can a powerful steamer get down from Dover to Dungeness, the wind blowing hard?—It must blow particularly hard to prevent her.

Suppose a breakwater to be constructed in seven fathoms water, how many openings would you have?—Supposing the breakwater to extend from the shore, three.

Do you speak of your own knowledge of the holding-ground in Dover Bay?—Yes, from my own knowledge, from early experience; although of late years I have not been engaged in the Channel; circumstances may have altered, but I have no reason to suppose they have.

(*Admiral Dundas.*)—Can a powerful steamer get down to Dungeness if blowing hard?—It must blow very heavy to prevent her doing so, especially with an ebb-tide.

Supposing a breakwater constructed in front of the inner harbour, how many entrances would you recommend?—If projected from the main land, three; the one to the south-east to admit the ingress and egress of a line-of-battle ship under all imaginable circumstances.

Taking into consideration the prevailing winds, where would you place the western entrance?—In the south-west side.

And where would you place the third?—To the eastward.

Would you recommend a pier from Cheeseman's Head to be extended to the north end of the breakwater so as to shut out the shingle?—I think I should not do so; the question brings to my mind many serious and conflicting considerations, both as regards what may be the future results from the erection of the contemplated harbour of refuge and to the present port, as well as to the welfare of the town, by shutting in the Bay with a breakwater: I think I should be inclined to decide upon detached breakwaters, leaving a free navigable channel in shore, with not less than three fathoms water low spring-tides. Dover Bay is land-locked, viz., from east to west, or one half of the horizon; therefore the question resolves itself into the consideration of the best mode of giving shelter to the other and exposed half, by constructing a work that will create no dangers, nor injuriously change existing establishments.

(*Captain Fisher.*) During the time you have been at Dover, have you seen many or any vessels driven from their anchors while riding in the Roads?—Never, to avoid coming upon the shore, it is my opinion that many ships drive, not from bad holding-ground, but from defective and inefficient ground-tackle, and from the want of proper care; sometimes it is observed that ships ride through heavy gales when it was expected they would not do so; at other times ships drive, or part when there was no apparent cause.

(*Captain Washington.*) Suppose you were called upon to say why you give the preference to Dover Harbour?—There are many considerations to induce me to name Dover; first, its defences as a military station; second, its internal accommodation. The

Lieut. *B. Worthington.*

16th May, 1844.

present harbour to a great extent would supply the place of docks; and many light craft seeking refuge would come inside, when the outside became too crowded.

What is your opinion of the holding-ground?—I have always understood the anchorage cannot be better; referring to the marks I have before stated, it is excellent anchorage in clay or mud; not better holding-ground in the English Channel.

[*The Witness withdrew.*]

Friday, May 17th, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *E. K. Calver.*

Mr. E. K. *Calver,* Master and Assistant Surveyor, H.M.S. "Blazer."

(*By the Chairman.*) How long have you been employed in surveying?—Eight years; three afloat, and part on shore.

In sailing through the Brake Sand the other day, did the depth of water agree with your expectations?—There appeared to be a less depth by three or four feet throughout.

Should you think the anchorage within the Brake a fit place for a harbour for a squadron of ships-of-war and a refuge for the trade?—Not at all fit.

As a seaman, and being intimately acquainted with the coast, what place between the North Foreland and Portsmouth do you consider the most desirable as a rendezvous for a squadron of steamers-of-war, for the protection of the trade of the Channel, and to serve as a place of refuge for the trade?—Dover.

You were employod in surveying the East Bay of Dungeness?—I was.

Do you consider it a favourable place for the construction of a harbour or breakwater?—No.

And why not?—Because it offers no available space within a moderate distance off shore. Also because you merely improve upon a naturally good roadstead.

Does the water suddenly deepen in the direction of the Swallow Bank?—Yes.

In what depth of water would a breakwater be placed if constructed one mile from the beach?—In a general depth of two fathoms.

At what distance from two fathom soundings would you find seven fathoms in low-water spring-tides?—One mile.

Then a breakwater, placed in seven fathoms low-water spring-tides, would be two miles from the shore?—Yes.

Is the anchorage on each side of Dungeness as it now is, without a breakwater, a good anchorage for a squadron of steamers, they being able speedily to move to either side on a change of wind?—Very good.

To what winds is the anchorage now exposed, including both sides?—From east and by south; south about to south-west, 11 points.

Have you been lately employed in making a detailed survey of Dover Bay?—I have.

In making the survey, how often have you anchored in Dover Bay within the last month?—Eight or ten times.

Having anchored so often, you will be able to state accurately the quality of the bottom as a holding-ground?—Good in smooth water only.

Should you consider it a safe and good holding-ground if surrounded with a breakwater harbour in the worst weather?—Yes.

What anchors is the "Blazer" supplied with?—Porter's.

In breaking the anchors out of the ground during the several times you anchored there, did you find they had a good hold?—They always brought up chalk.

Did you at any time, either then or previously, anchor there when it was blowing strong from the south-west?—Never to my recollection.

You have served a great deal at Harwich and surveyed the harbour and anchorage?—I have.

Do you think anything can be done there to make it a safe anchorage for a squadron of ships-of-war?—Easily, at a small expense.

By what means would you effect this?—By joining the Cliff-foot Rocks to the Beacon Cliff by a slight breakwater, its extent being about 800 yards or less, and dredging away the corners of the shoals in the eastern channel.

(*By Sir Howard Douglas.*) Did you ever find difficulty in heaving up your anchors in Dover Bay?—They never had hold enough to cause any difficulty.

Do you not consider that as the general quality of the ground, and as denoting the measure of good holding-ground?—I consider it a good test.

(*By Admiral Dundas.*) Is the holding-ground in Dover Bay more inclined to chalk to the east of the Castle Jetty than to the westward?—Well, out in deep water, it is.

How many entrances would you recommend for a harbour before Dover, and if two, where would you place the western entrance, so as to prevent the south-west sea and

Mr. *E. K. Calver.*

17th May, 1844.

the shingle from rolling in?—I would have two. The southern entrance should be passed by the west-south-west wind at as near a tangent as possible, that being the heaviest sea.

Would there be any difficulty or danger, supposing the southern entrance was 700 feet wide, for any vessel to enter in or go out across the tide, and in a strong breeze of wind from west-south-west?—But little; and I consider that it would be quite removed if made wider, say 300 yards at high water.

How far from the eastward of Cheesman's Head would you have your principal entrance to the harbour?—Nearly half the extent of the harbour.

(*By the Chairman.*) How does the quality of the bottom at Dover compare with the general anchorage in the Downs?—Inferior to the Downs.

(*By Sir H. Pelly.*) You stated the anchorage in Dover Bay as good in smooth water only; what do you mean by good?—I mean good for smooth water; but directly a lift occurs, it is so no longer; but if surrounded by a breakwater, I consider it would be good under all circumstances.

(*By Captain Fisher.*) In making your survey of Dover Roads, what was the general nature and quality of the bottom?—Within seven fathoms, chalk, with a smooth surface here and there covered with ross, an animal substance or worm cast.

Were you in Dover Bay during heavy blowing weather, with wind from the southward and westward?—Never.

What is the set of the tide in the line of the proposed breakwater?—The outer part east by north, and west and by south.

Are you of opinion that vessels seeking shelter in a harbour constructed in Dover Roads could proceed on their voyages out or homeward as may be, in all winds and all weathers?—Easily, under all circumstances.

Are you of opinion that ships seeking refuge could make their passage down Channel under circumstances that would prevent them from doing so, from a harbour in Dungeness East Bay?—Yes.

(*By the Chairman.*) Where would you propose an eastern entrance to a harbour at Dover?—In from four to five fathoms at low water.

(*By Lieut.-Col. Colquhoun.*) Would the eastern entrance be affected by the tides?—It would be nearly still water on flood and ebb.

(*By Sir William Symonds.*) Did you ever anchor in a sailing-vessel in a heavy gale under Dungeness with winds from south-west to west-north-west?—I have.

In very heavy gales?—In gales of a general nature during the winter.

Did you ever find the anchorage good?—Yes.

Both as a shelter and as a good holding-ground?—Yes.

Were you ever at anchor on the west side of Dungeness in a heavy gale from east to north-east?—Not to my recollection.

For what period have you ever been in active employment in sailing-vessels using the narrows belonging to sailing ships?—During the principal part of the winter of 1832, cruizing for Dutch merchantmen.

In what ship?—The "Satellite," Captain Robert Smart.

Did you keep the sea in all weathers?—Yes, either about Dungeness, or on the Dutch coast.

How long were you at sea during that period?—With a very few exceptions, from October to the following spring.

You say that in smooth water the holding-ground off Dover is good; is it equal to the ground at Spithead, the Downs, Dungeness, Plymouth Sound, and the ports commonly used by men-of-war?—It is not equal in quality; but in either case the anchors will hold in smooth water.

When you anchor in Dover Bay, is there not a particular mark for the best ground—do you allude to that ground in your evidence—do not you always anchor in the best ground?—There is a particular mark for the best ground, but I allude to the bay in general.

Have you anchored in all parts within the proposed harbour, and tried the nature of the bottom?—Generally in a depth of from 5 to 7 fathoms, but not in every part of the bay.

Do you consider that sailing-vessels are more liable to drive on indifferent ground than steam-vessels that are lightly masted, low and light in the water?—In a tideway they are the same; for that which acts against the ship, on account of masts and yards, is about made up by the resistance of the steamer's paddle-wheels.

You say the "Blazer's" anchors are Porter's; have you used other anchors in her or other vessels in Dover Roads, and found the same effect with regard to the ground?—Porter's anchors only.

In answer to Captain Fisher's question relative to getting out of the proposed harbour off Dover, did you consider the difficulty of moving ill-manned and unwieldy merchant-vessels, who would feel a tide of four knots running across the opening between the piers, which of course they would have to contend with under any circumstances?—The difficulties they would meet with in going out by the south entrance they would avoid by using the eastern one.

And how would they get to the westward if bound down Channel, the wind S.S.E. blowing a hard gale?—They would leave the harbour by the south entrance, while the flood was running; when out, there would be no difficulty.

In light baffling winds what would be the consequences, the wind being as before?—If enough to give steerage-way, they would act the same.

Mr. *E. K. Calver.*

17th May, 1844.

(*By the Chairman.*) In any difficulty, would not the tug vessels be always at hand to assist?—I should consider them a necessary appendage.

(*By Captain Fisher.*) In reference to Sir William Symonds' question, which referred to one put by me, supposing even that there is a tide running four knots, as you have stated the tide sets from west and by south to east and by north, would it not in that case rather assist a ship in getting out of the harbour, with the wind at S.S.E., instead of obstructing her?—Undoubtedly.

(*By Admiral Dundas.*) Are you acquainted with Beachy Head and the shoals east of it?—I have a slight knowledge of them.

If a breakwater was to be constructed, on which side of Beachy Head would you recommend that it should be placed?—On the west side.

(*By the Chairman.*) For what reason do you give the preference to the west side?—I think the ground is more available, from its slope; a breakwater of any given length would afford greater protection, and a vessel would be kept away from the shoals eastward of Beachy Head. I speak of Newhaven because it is the head of the bight.

Have you surveyed the bay on the east side of Beachy Head?—I have.

When you surveyed it had you the position of any proposed breakwater marked on the chart?—Yes.

And what was the distance of the proposed breakwater from the shore?—A little over a mile.

What distance would such a breakwater be from the two fathoms low-water spring-tides?—Less than half a mile.

What is the quality of the bottom between the breakwater proposed and the two-fathom depth?—Sand.

Do you consider it good holding-ground?—I do consider it good.

(*By Admiral Dundas.*) Suppose a breakwater on the east side of Beachy Head, with a light on the Head and another on the west end of the breakwater, would there be any danger in a ship running in during the night from the Sovereign Shoal, which lies five miles off?—In misty weather, certainly; but only then.

(*By the Chairman.*) If a breakwater or harbour were to be constructed at the bottom of the bay at Seaford, do you consider that vessels in blowing weather would hesitate to run in?—No; for they would close the fair coast to the westward, free of dangers, and run along in a certain depth.

And how far would that certain depth be from land?—A mile off shore, and the depth, 7 fathoms.

Would not a vessel running in in such weather be going at too great a rate to get soundings?—She might get that depth without difficulty.

If equally good anchorage could be found on the east side of Beachy Head, on which side would you rather have a harbour, if running in from a south-west gale?—To the west; because Beachy Head light is generally available, and I should avoid the dangers of the Holywell Bank and the Royal Sovereign Shoal.

How far does the Holywell Bank lay off the shore?—I believe at an average of half a mile.

Is there about the Royal Sovereign Shoal so little water as 7 feet?—Ten is the least I have heard of.

Did you sound on the Sovereign Shoal when surveying there last month?—No.

How far is the Sovereign Shoal from the proposed breakwater?—Three and a half miles.

In rounding the Head in heavy hazy weather, it would be necessary to give a berth to the Holywell Bank which might carry vessels seeking shelter there (under a breakwater) towards the Sovereign Shoal?—It would entail two evils, either of closing the Sovereign Shoal or of missing the harbour of refuge.

(*By Admiral Dundas.*) Supposing there was merely a small breakwater east of Beachy Head for steam men-of-war, would you consider that a better position for them than to the westward?—By no means, because the inner water at Newhaven gives superior advantage for a refit.

Is not Newhaven a dry harbour?—It is; but as I propose using it for refit, and not for refuge, this would offer but little difficulty.

(*By Captain Fisher.*) Would there not be more risk in a deep-laden merchant ship coming from the westward, and seeking shelter, running for a harbour of refuge to the westward of Beachy Head than to one constructed immediately to the east of it?—I think not; for by adhering to the plan before mentioned, she would never be led so far to leeward as to be unable to weather Beachy Head on the starboard tack.

From a harbour constructed to the eastward of Beachy Head, would vessels bound to the eastward find any difficulty, in westerly winds, in running out between the shore and the Royal Sovereign Shoal and other shoals?—No difficulty.

(*By Mr. Walker.*) In stating your objections to a breakwater at the Brake, you stated that the soundings taken on the 15th were 3 to 4 feet less than you expected, would the objection apply with the same force if the soundings had been as deep as you expected?—Yes; for by interfering with the set of the tide through the small Downs, the scour would be lessened, and a disposition to sand-up be brought about.

Is that your only objection?—It is my principal one.

Would you be so good as to state what other objections you may have?—Because I think the same sum of money might be better devoted in constructing a harbour where none really exists.

Mr. *E. K. Calver.*
17th May, 1844.

Does the objection to a harbour within the Brake being likely to sand-up, through an interference with the set of tide, apply to Dover?—No; because I have light sea-sand to contend with in the one case at the Brake, and not at Dover.

Do you apprehend any silting up in any harbour, if constructed in Dover Bay, through the water held in suspension, during westerly gales or otherwise?—It would share with Ramsgate Harbour as to this particular, but in a less degree at Dover, as it would have a greater space to fall through before deposited.

You stated that the greatest objection you had to a harbour at the Brake was its interference with the tidal current, would that objection apply with at least equal force to a harbour at Dover?—No; for I have different materials to contend with; the same interference would exist, but it would have less effect as to deposit.

You stated that you would recommend the southern entrance at Dover to be placed, so as to be nearly at a tangent to a W.S.W. direction, will you, by looking at the plan, state whether that opening, No. 3 A, agrees with your view?—Not exactly, as the east pier head is not covered in sufficiently by the west pier head.

How should that be remedied?—Either by carrying the west further out, or bringing the east further in.

You gave us very particularly your views on the southern entrance, will you state your views upon the eastern, looking at the plans before you, and the entrance marked C, which lies east and west at a distance of about 600 yards from the shore?—It appears well arranged.

Do you know Plymouth Breakwater?—I do.

Do you think that as much above high water as the breakwater proposed at Dover would require to be?—Quite sufficient.

(*By Sir W. Symonds.*) Will the fresh-water stream, and the silt and mud now deposited in Dover Harbour, have a good or bad effect on the large one when formed, as to deposit?—A bad effect; so much so, that I should consider it necessary to cut off the communication between the inner and outer harbour.

With reference to one of your replies to Mr. Walker, would not the flood-tide be altered in its direction when rushing round the south-east corner of the harbour, thereby rendering the passage out by the eastern entrance to slow sailing unmanageable vessels dangerous?—I think not; the water would be perfectly still for two or three cables' length off.

(*By the Chairman.*) Will that still water have a tendency to deposit?—I think not, because any deposit which would take place during the flood would be removed by an accelerated tide during the ebb.

Do you consider that adding to or prolonging the south face of the breakwater that any eddy would be prevented, and a truer direction given to the tide?—It would, but I do not think the advantages gained would be equal to the cost of erection.

Do you consider that an opening on the east from the shore, between high and low-water mark, would tend to give an increased effect to the current, and so prevent a tendency to deposit?—It would be slightly beneficial, but this would be out-balanced by the shingle which would be thrown in by easterly gales.

(*By Sir H. Pelly.*) In answering the question respecting the effect of the tide across the entrances, have you taken into consideration the fact, that half the ebb or falling tide runs to the eastward and the other half to the westward?—I have considered it only as a tide running six hours one way and six hours another, without any reference to its rising and falling, as it is a harbour of refuge and not a tidal harbour.

(*By Captain Washington.*) Is there not an eddy tide in shore, on the flood stream in Dover Bay?—Yes.

Is there not a fear if an eastern entrance be left that the eddy on the flood stream will turn in at it, and meeting the main stream of tide flowing in at the central entrance, cause it to deposit the silt it holds in suspension?—None whatever, as the eddy on the flood would be done away with by the erection of the breakwater.

From the effort the flood-tide coming up Channel will make to enter at the central entrance, will there not be an indraught into the proposed harbour that will materially assist a ship wishing to go in—and would not the same assistance be given to ships in leaving the harbour on an ebb-tide?—Certainly.

What do you consider would be the proper width of entrance to admit of large frigates and East Indiamen entering at all times, and if necessary, to enable them to work in or out?—Three hundred yards at high water; speaking of large ships and working out.

Will you state the advantages of a central entrance into an asylum harbour in Dover Bay over an entrance farther to the westward?—With a western entrance, after a certain number of years, the shingle would block up the space to the westward of the western breakwater; it would then work out and fall round the end of the breakwater into the still water of the harbour of refuge; when there, there are no natural means afforded for getting rid of it.

(*By Sir H. Douglas.*) Would not the harbour be more likely to silt up if there were only one entrance?—Certainly.

(*By the Chairman.*) Do you think that by a harrow or other means of disturbing the bottom, that it would be kept clean?—It would have but a slight effect, on account of the want of in-draught and out-draught.

Do you not think that an active tide would be passing if there were two entrances,

Mr. *E. K. Calver.*
17th May, 1844.

and an opening disconnecting the east pier and the shore?—The rate would probably be a quarter that of the stream tide.

(*By Captain Washington.*) By leaving an eastern entrance, will you not isolate nearly half the breakwater, and cause difficulty in shipping supplies, in coaling steamers, and in landing passengers in an easterly gale?—All that traffic I would carry on on the western breakwater, which would have a communication with the terminus of the railway.

Would there not be great difficulty in doing this in an easterly gale?—None.

Is it a heavy swell and sea, or a strong wind that usually causes a ship to drive from her anchors?—By the sea under most circumstances, the swell having a tendency to trip the anchor.

During the twenty or thirty times we may have anchored in Dover Bay, in the "Shearwater," and "Blazer," have we not always anchored within the limits of the proposed breakwaters?—Always to my knowledge.

Has the ship ever driven from her anchor?—Never.

(*By Lieut.-Col. Colquhoun.*) Will the accessibility of the proposed harbour be interfered with by the force of the discharge of water from it on the ebb?—Not at all, if there are two entrances.

(*By Admiral Dundas.*) Would you not think it advisable to leave an eastern entrance open on the first formation of the harbour of refuge, and if found to disturb the ships in the harbour by the wind, sea, or tide, it would be very easy to fill it up?—It would, because the filling in is easier done than the making an opening, if found requisite.

[*The Witness withdrew.*]

Mr. *Werter Clark.*

Mr. *Werter Clark,* Pilot, re-examined.

(*By the Chairman.*) Have you anything to add to your previous evidence respecting your opinion as to constructing a harbour at Dover?—I consider it a very eligible place on account of its situation, as being within a short distance of that point of land, the South Foreland, which all vessels coming from or bound to the River Thames must necessarily approach, and also being within a common tide sail of the Downs.

Is Dover a good holding-ground?—Some good spots, but generally not good.

[*The Witness withdrew.*]

EASTBOURNE.

Lieut. *John Conjuit.*

Lieut. *John Conjuit,* R.N., Coast Guard.

(*Chairman.*) How long have you been at this place on the Coast-guard service?—12 years at this place.

Have you, during your long residence, made a general acquaintance with the anchorage in front of the town?—Not particularly, only by repeated observation of the proceedings of vessels.

During your time how many vessels have been seen wrecked?—Four.

Under what circumstances?—Two from previously having been on the Beachy Head reefs, and two others springing a leak at sea, and running on shore purposely near the Circular Redoubt.

What was the state of the weather?—In one case, thick blowing Channel weather; the other, in consequence of pilot's keeping too near Beachy Head, having under his charge an Italian vessel, and not making himself acquainted with her draught of water; he first struck upon reefs off Beachy, then drifted down upon Holywell Reef, when an English pilot and nine Italians perished.

How was the wind?—In the first case from S.W., veering to W.S.W.; second case (viz., Italian vessel), W. and W. by N. These cases have occurred since the erection of Belle Tout light-house, about 18 months since.

Have you ever seen a square-rigged vessel riding at an anchor in Eastbourne Bay in heavy weather with the wind blowing into the bay?—No.

Have you ever seen vessels embayed here have a difficulty in working out?—I have never observed any.

Have you ever observed vessels strike on the Royal Sovereign Shoal?—Two.

Under what circumstances?—Wind moderate, and fine weather.

How was the wind?—In one instance W.S.W., the other instance nearly N.

What became of the vessels?—They floated off upon rising of tide, and refused any assistance.

Lieut. *John Conjuit.*

17th May, 1844.

What description of vessel?—Square-rigged barques, timber-laden, drawing probably 15 or 16 feet water.

(*By Sir H. Douglas.*) Where would you propose placing a breakwater?—From Langley Point, embracing the Circular Redoubt.

In what depth of water?—Six or seven fathoms water.

What would be its extent?—About two miles in length, without the eastern and western arms.

Being at that depth, how far off the land would that breakwater be?—I should say a mile and a-half, but have never ascertained the correct distance.

Would such a harbour be much resorted to for shelter by the trade?—I am of opinion it would every winter season.

Do you think a harbour of refuge on this east side of the Head would be more useful than one on the west?—I think it would.

Why?—The prevailing gales are S.W., as I have noticed hundreds of vessels taken with a head wind upon their reaching Eastbourne Bay, and owing to heavy seas off the pitch of Beachy Head, unable to get round, and generally bearing up either for anchorage under Dungeness or the Downs.

(*Admiral Dundas.*) What number of vessels have you ever seen take shelter in the bay in W.S.W. gales at one time?—Not more than a hundred.

Have you ever seen a steamer lying there?—Several large steamers.

Did you ever see a ship caught in this east bay with the wind blowing hard in and she held on at her anchors?—I have not.

Does the wind fly round from W.S.W. generally to N.W.?—It generally does in winter months.

Does it fly back to south?—Very rarely.

(*Captain Fisher.*) Could vessels outward bound seeking refuge at this anchorage lie round Beachy Head and the Boulder or Holywell bank or shoals with the wind southerly, which would take them down Channel?—Yes, with the distance of about two miles from the shore, giving a weather-start from their anchorage.

Could vessels bound to the eastward go out with facility from this anchorage between the Sovereign Shoal and the shore in all winds that would be fair round Dungeness?—Yes.

Do you apprehend or know of any difficulty that vessels would experience in reaching this harbour from the westward at any time of tide and very bad weather?—I do not apprehend or know of any danger or difficulty.

What is the set of the tide close in with the Head and along the shore to Langley Point?—Flood tide sets off from Beachy to S.E. (offing strong), with no great indraught to Eastbourne Bay.

What holding-ground generally is in the space of the proposed harbour?—Stiff mud and sand.

(*Sir Wm. Symonds.*) Are you sure it is clear ground where you would place the breakwater?—I have every reason to believe so, having swept over it with sweeping-lines and creeping-irons.

Do trawlers ever use it?—At all times.

What is the effect of S.E. gales,—do you remember to have observed a heavy ground-swell when it blows so?—Heavier swell from that wind than any other point, lasting only during the gale, which is of rare occurrence.

(*Captain Washington.*) What is the greatest number of vessels you have seen anchored in Eastbourne Bay under any circumstances at one time?—In N.W. gales from 50 to 60.

Any of large burthen, and what?—From 500 to 600 tons, (in one instance a French naval store brig of burthen); others, laden colliers and coasters.

What is the movement of the shingle on this side Beachy Head?—Varies much; at times leaving a level sandy strand; the south-west winds carries an accumulation of shingle to Langley Point.

Do the north-east or south-east gales bring it back?—The north-east partially; south-east not.

(*Chairman.*) Does the Holywell Shoal appear to give much shelter during south-west gales?—It does, preventing heavy seas immediately opposite the Sea houses, and sheltering the bight of the bay to Langley Point.

(*Lieut.-Col. Alderson.*) Does the sea encroach here?—It does annually to the westward, where there are no groynes.

Is not that beach retained by groynes?—It is by several to the eastward.

[*The Witness withdrew.*]

William Simpson, Fisherman.

William Simpson.

(*Chairman.*)—Are you a pilot?—No.

Do you ever trawl?—Yes.

How far off?—Between this and the Sovereign Shoal.

William Simpson.

17th May, 1844.

Have you trawled all the way between this and the Sovereign Shoal?—Not above a mile from the shore.

Why not farther?—Because there is no trawling-ground; it is all hard ground.

What sort of bottom do you find there where you do trawl?—A good bottom and sand; good holding-ground; but to the south-west of the beach houses the ground is not good for holding; but in front and to the eastward the ground is good.

How far off from this shore do you get two fathoms at low-water spring-tides?—Rather less than a mile.

And how far seven fathoms?—About a mile and a half.

Have you ever known a vessel get on shore on the Royal Sovereign Shoal?—Yes, two.

What were they?—Two timber ships.

What became of them?—They both got off again, there was about 12 feet water where they were lying, over the rocks.

Have you ever been much on the west side of the Head?—Yes, about Seaford and Newhaven, driving for mackarel.

Have you ever trawled there?—No.

What bottom is it?—Smooth sandy bottom in Seaford bay.

Have you ever seen ships bring up in Seaford Bay?—Yes, when blowing from the eastward.

Have you ever seen ships riding when the wind was blowing in?—No.

Have you ever seen ships riding in the Eastbourne Bay during a gale from the eastward?—No.

How many have you seen in this bay at a time?—50 or 60 in westerly winds.

(*Admiral Dundas.*) Is there any buoy on the Sovereign Shoal?—None.

Did you ever see a large steamer lie in Eastbourne Bay?—Irish and other steamers in winter.

Do ships in general avoid this bay and bear up for Dungeness?—They do; strangers especially.

Is that from fear of the Sovereign Shoal?—Rather from not knowing that there is good holding-ground.

Did you ever know the wind fly back round to the southward, or does it generally fly round to the Northward?—Generally to the northward.

Do you think a breakwater protecting the bay from the eastward would be of any service here?—Yes.

(*Mr. Walker.*) For what purposes?—For all crafts.

(*Sir Wm. Symonds.*) Do you know the Horse of Willingdon?—Yes.

How far from the Royal Sovereign?—Two miles south-east nearly.

What water on the Horse?—It varies, and never less than four or five fathoms at low-water spring-tides to my knowledge.

Are there not some other shoals not far distant from the above mentioned?—Several; all shoal water.

Of what extent do you think that cluster of shoals is?—From the inner edge to out, or from north-west to south-east, about five or six miles; and from south-west to north-east, about half that.

(*Capt. Washington.*) Did you ever see or hear of any privateers in Eastbourne Bay?—Several.

(*Mr. Walker.*) Is there a good deal of shingle on your beach; is it always there?—Yes.

Have you never seen the beach between this and Langley Point clear of shingle?—I have, but very rarely.

In trawling, do you find any shingle?—No, but we find large flint chalk stones sometimes towards Pevensey Bay, but the shingle is only found between high and low water.

[*The Witness withdrew.*]

William Head.

William Head, Fisherman, aged 37 years.

(*Chairman.*) Have you resided here all your life?—Yes, as a fisherman.

What sort of ground is it off here?—Sand for about three miles, then rocky.

Is there much rock in the bay?—Not till three miles off shore, and then a good deal; large rocks on the Horse of Willingdon.

(*Mr. Walker.*) In trawling, do you ever find shingle below low-water mark?—No.

(*Admiral Dundas.*) Do you find vessels anchor here in south-west gales?—Yes.

Did you ever know ships ride out an easterly gale in Eastbourne Bay?—No.

(*Mr. Walker.*) How is the bottom of this bay as compared to Seaford Bay?—The ground here within the shoals is about the same.

Have you seen many ships take refuge in Seaford Bay during an easterly gale?—Many.

[*The Witness withdrew.*]

Lieut. *Robert Mann.*

17th May, 1844.

Lieut. *Robert Mann*, examined.

(*By the Chairman.*) How long have you been on this coast?—Thirteen years at the Hastings station.

Are you at all acquainted with this part?—No, only the locality of Hastings.

Did you ever command a Revenue Cruizer?—No; never.

You cannot therefore give us any information respecting this situation?—No; Hastings is 18 miles from this, and my duty confines me to that place, about which I am well acquainted, and have sent reports respecting it to the former Committee on Harbours.

[*The Witness withdrew.*]

Richard Harman.

Richard Harman, Ship-owner.

(*By the Chairman.*) Have you any knowledge of the anchorage in Eastbourne Bay?—Yes, it is a sandy bottom; not a very good holding-ground.

How far out is the good holding-ground?—From 3 to 3½ miles.

Did you ever cut or chafe your cable?—No, never.

Have you ever known a ship to ride in Eastbourne Bay in heavy weather?—No.

What is the greatest number of vessels you have ever seen at one time at anchor in Eastbourne Bay?—About 20 sail.

Do you consider the Boulder Bank or Holywell in the way of the navigation?—I do; it is dangerous in hauling round the Head

How many vessels have you known strike?—I have witnessed four or five, and I have heard of more.

Have you ever anchored above the Sovereign Shoal?—I have not.

Have you been much accustomed to Beachy Head?—I have, in the coasting trade.

Suppose a harbour constructed on either side of Beachy Head, which do you suppose would be the best?—The eastern side.

Why do you consider the eastern side?—The prevailing winds being for 9 months south and westerly winds.

Should you not consider the Boulder Bank which you describe as so dangerous, and the Royal Sovereign Shoal an objection to drawing vessels to an anchorage in this Bay?—I think so.

Do you know Seaford Bay?—I do.

How often have you been riding in Seaford Bay?—A hundred times.

What places have you been trading to?—Coasting generally.

What is the nature of the bottom in Seaford Bay?—Good holding-ground.

Did you ever ride there with a gale on the shore?—Never did.

(*By Admiral Dundas.*) Does the wind fly suddenly round from the westward to the south, or generally to the northward?—Yes, to the north; after blowing strong it generally flies in to the northward, with heavy showers.

Do you think, now, the government steamers could with perfect safety keep the sea for the protection of the trade, by moving round Beachy Head as the wind changed from westward to eastward, in all weathers?—No; there can be no protection in either bay, when it blows hard from south-west.

In which bay could you put a breakwater to protect the cruizers from south-west gales, so that they may be always kept on their station?—A breakwater might be put from Langley Point, in a south-east direction, to protect Pevensey Bay.

Would you run that breakwater from the shore or not?—From the shore, there being good water at the point; I would make it in the form of a half moon.

What water is there?—From five fathoms to seven fathoms.

What distance off the land would you find seven fathoms water south-east from Langley Point?—About two miles and a half.

Have you ever had a plan?—No.

Could a harbour be constructed to protect Pevensey Bay, accessible at all times of tide, wind, and weather; day and night?—I should doubt it.

Do you think that steamers could keep their stations when it blows hard from the southward and westward?—Certainly not.

(*By Captain Fisher.*) Have you long commanded a vessel in the coasting trade, and have you frequently anchored in this bay?—Frequently.

Could large ships, bound to the eastward, go out of this bay, between the Horse of Willingdon, the Sovereign Shoal, and the shore, with a wind that would take them round Dungeness?—Yes.

And could vessels bound to the westward also, from their anchorage, round Beachy Head, and the Boulder Bank, with the wind not to the eastward of S.S.E., or to the west-

Richard Harman.

17th May, 1844.

ward of south?—With the wind at S.S.E., they would clear the Head and the Boulder Bank.

Do you know of any difficulty that vessels would experience in entering the harbour from the westward at any time of tide and in heavy weather?—Not if proper lights and guides were erected.

What sort of holding-ground generally will be found within the space of the proposed harbour at Langley Point?—Very good.

(*By Sir J. Pelly.*) Is there any place, in your opinion, in which a harbour could be constructed between Newhaven and Dungeness?—None.

(*By Captain Washington.*) From your knowledge in the coasting trade, what do you consider the most eligible place for a harbour of refuge between the Thames and Portland?—Dungeness.

(*By the Chairman.*) How far out do you think the shingle at Dungeness has extended in your time?—About 100 yards.

(*By Mr. Walker.*) Have you any other objection to Dover as a harbour of refuge except on account of the accumulation of shingle?—No.

(*By the Chairman.*) What do you consider the general character of the bay eastward of Beachy Head?—Generally shoal water from Beachy Head to Fairlight.

[*The Witness withdrew.*]

William Breach.

William Breach, 40 years a Fisherman.

(*By the Chairman.*) What is the nature of the ground between this and the Sovereign Shoal?—Sandy soil till you come to rocks.

And how far is that?—About 5 miles.

How old are you?—70 years.

Do you recollect any ships being lost here?—Several.

What?—The "Thames," a West Indiaman, and many wrecks in various places; twenty of different nations.

Have you ever seen a ship riding out a gale off here when blowing on shore?—Never, but many off Hastings; it is very good ground off Hastings.

How many ships have you known lost off Holywell Bank?—Several; many were lost before the light-house was erected; I imagine they mistook Beachy Head for South Foreland, at that time; and hauling round, they struck on the Boulder Bank.

[*The Witness withdrew.*]

NEWHAVEN.

Saturday, May 18th, 1844.

Admiral Sir T. Byam Martin, in the Chair.

William Stevens.

18th May, 1844.

William Stevens, examined.

(*By the Chairman.*) What is your situation here?—Harbour master.

How many years have you been in that situation?—About 15.

And what situation of life were you in before you came here?—I think for about a dozen years before I did nothing. I had left off the sea; but for 27 years before, I was always at sea.

Did you ever command a coasting-vessel?—Yes.

During war?—Perhaps half a dozen different vessels, from the East Sea to Dublin, for perhaps 27 years, and coasting-traders.

What was the state of the harbour when you first came here, and how many years ago is it?—Fifteen.

And what have been the improvements? describe the state of the harbour when you first came?—When I first came there was what we call a dickey-work, a low jetty-work. It ran out of the east pier parallel with the west pier, about 4 feet above low-water mark, and was intended to lead the water straight into the sea, but failed to do so. Then I think there were four acres of dry beach before the harbour at low water, when the wind was from the south-west, partly on one side and partly on the other. The water had left it. Then, about nine years ago the east pier was extended to put the water straight; this dickey-work did not do the work well. Then the east pier, about nine years ago, was lengthened, and carried out parallel with the west pier, right over the dickey or

William Stevens.

18th May, 1844.

jetty-work that was built into it. That set the tide so powerfully upon the beach, that it cleared it away in the first two years. Since that time we have not had half an acre of loose beach crossing the harbour at low water at one time.

What work are you now about for the improvement of the harbour?—Carrying out the groyne to the west of the harbour for a length of 500 feet from high-water mark.

What depth will the end of the groyne or pier have at low-water spring-tides; and if it should be carried out 500 feet further, what depth of water will it take you into?—About six feet of water at low spring-tides.

Going out in a direction seaward over the Fricker Rocks, at a depth of six fathoms, what is the quality of the bottom?—I should think it may be a great part of it chalk rock. Rather low, soft chalk; other parts, clay.

A hard bottom?—Rather hard; chalk rock.

When I speak of a bottom, I speak of anchor-ground?—It is not too hard, I think, for an anchoring-ground.

Not sand upon it?—No, neither do I think the ground is so hard but what an anchor might hold. I never saw one come home there.

Have you ever seen any vessel riding there in blowing weather?—Riding very heavy gales at times.

A good deal of sea coming in?—Yes.

Are you speaking of frequently seeing vessels lying there in a blowing wind, with the wind on shore?—They do not choose it; but when they are caught, I have seen it many times.

And under such circumstances, do you know of any instance of their parting or driving?—No.

Then what you are stating would seem to show that it is good holding-ground?—Yes, it must be good, but not so good as the bay.

The sea you are describing made the vessels pitch?—Very much.

Where do you consider the good holding-ground to commence, going towards Seaford?—I should think, from this breakwater, the whole bay altogether good to the eastward.

You are speaking now of going out considerably over the Fricker Rocks, do you mean to say that all this anchorage in front of the harbour, within the line we are speaking of, to the south-east, is good holding-ground?—I never knew to the contrary.

Do you consider the ground, to the front of the harbour seaward, to be as good as it is down more towards Seaford?—Yes, I never saw anything to the contrary; I never saw an anchor come home there in my life.

Have you ever sounded it yourself?—Yes; but it is a good many years ago. I suppose there is no alteration.

At what expense is the estimate the work will be that is now in progress?—I think it may be about 1500*l.*

And if carried out to a thousand feet, what do you suppose it would be?—Why, there it would come heavy; there you would more than double the expense. I think perhaps 4000*l.* additional.

Look at this chart; suppose it should ever be decided to have a harbour constructed, or a breakwater, where do you think it would be best placed?—I should think in the direction of the Fricker Rocks will be best.

But that would be no protection from the south and easterly winds?—Not the least.

What would you propose for that?—No better than what is laid down here, running to th esouth-east.

Now in point of fact, would it not be a better thing, and enclosing what is generally considered better ground, to carry it more to the south-east, in front of Seaford?—No, I should think not any better; I should say this is the best plan.

And why do you say this is the best plan?—Because it is in every way formed the best; and if you needed any southerly protection, run it off from Seaford Cliff.

If the anchorage here in front of the harbour is as good as it is to the south-east, fronting Seaford, why is it that the 22 vessels now lying at anchor are all down in the Seaford Roads?—I think if they were all here they would say it would be as well to ride at this port off the harbour, only it is convenient for them to get ashore there to get provisions.

Would it not be more convenient for them to go on shore at this town to get provisions than down at Seaford?—There is a drift of two miles between that and the pier where they lie, and that makes a bubble of a sea. A little ship that has got only two hands to send on shore here could not do it so easily as they can up there, lying close to Seaford.

Are you aware of any rocky ground at Seaford?—I think there is a little a short distance off, but I am not well aware of it; I think, nothing to damage the anchor-ground.

Do you know of any borings made in front of your harbour to ascertain what is under the sand?—I do not know.

Do you know of Captain Bullock having made any borings?—I heard him say he had.

What is the breadth of the entrance between the piers?—110 feet or thereabouts.

Is that found, practically, to be inconvenient or too narrow for the navigation?—No, not for our own trade.

At what time of tide do vessels generally pass into the harbour?—Colliers of 12 feet water pass in, I should think, an hour and a half before high water.

William Stevens.

18th May, 1844.

Do vessels go out at all times of the ebb whilst there is water for them?—Not always; they do not consider it safe; they prefer high water.

They do not go out in a falling tide?—They do not like to do it.

What is the inconvenience?—Because if they get a-ground, they lie ugly upon the river.

Is there anything that you can suggest for the improvement of the interior of the harbour?—Yes, it might be widened.

Do you mean widened at the entrance?—Yes, and deepened.

Describe in what way, and to what extent you would widen it?—Upon the east pier from 40 to 50 feet, so as to make the entrance 150 feet wide.

And having done that, would you continue the passage up the harbour at the same breadth?—Within the pier head I would make the harbour wider.

If you were to make the harbour wider within, would there be no fear of its diminishing the strength of the back-water?—I should think, not much. In widening the pier, I would propose to extend both piers not less than 200 feet further into the sea.

Would you propose the east and the west piers running out to an equal distance?—Exactly so.

What water would you carry your pier head into?—A foot and a half more than it is now.

What do you hope to gain by carrying it out to that distance, when you have only a foot and a half more water by it?—Why, I think it would put the ebb-tide straight into the sea, and the materials might be dredged to almost any reasonable depth.

That being your object, would it not be better to extend the pier still further out?—I think 200 feet would be sufficient; not less than that.

If it were carried further of course it would accomplish your object the better?—Yes, 400 feet would be better.

Now supposing that done, and, instead of widening the harbour as you are proposing, a wall should be carried along the present line of the harbour there, turning this marsh-land on the east side of the harbour into a wet-dock, supposing that to be accomplished, should you consider it a great convenience and accommodation to the trade?—I do not think it would to the trade; the trade has got plenty of stowage nearer the town, and which might be easily improved.

You mean to the trade of the port it would not be a great accommodation, but to vessels coming in for shelter it would?—Yes.

Is there any particular action of any tide on the east pier?—No, not any.

I think Mr. Whitby, when he was down, made some observations about that?—There was then, because one pier was longer than the other. The tide then did not enter the harbour straight, and now it does.

If your piers were to be conducted to the extent you propose, would the natural back-water be sufficient, or would you have any additional sluicing power to force the shingle away?—I should think the natural back-water would be sufficient.

And that it would not be desirable to make Sleeper's Hole a back-water?—I should think not.

Now if your piers were extended to the distance proposed, or to 400 feet, how much beyond that do you suppose the effect of the tide could be felt, so as to clear the ground?—Perhaps 1000 feet beyond that.

Then at the end of that 1000 feet it would settle down?—I do not calculate we should have much loose material when we had got a breakwater to the westward.

Then at the end of the 1000 feet, where the back-water loses its effect, there the mud would settle down and form a bar?—I thinknot; the current out of the harbour would extend 1000 feet from the pier-heads, and further when the land-floods came down powerfully.

If an artificial harbour were constructed surrounding the present entrance, where would you propose to have the entrance to it?—For my own part I would not have an entrance from the westward at all, but one entrance only from the eastward. Since I have had time to think of the good or evil a 600-feet opening may do on the W.S.W. side of the breakwater, I beg leave to submit for your consideration, in very strong westerly gales, would not the sea come in powerfully and damage the best part of the anchoring-ground; and in fine weather, would not the strong flood-tide run in and cause a counter-tide; if so, it would disturb the well lying of the ships. I think this would apply to any other foul-weather erection put up between this and Dover.

Then if there was only one entrance, would not the tide tend to fill this up?—I think it might.

Have you any dredging-vessel belonging to the port?—No; we have some barges for dredging, worked by hand.

What are the charges upon ships entering this port—the harbour dues?—Twopence a-ton upon the register.

Do you know what is about the average of the annual produce?—About 2500*l.* a-year.

Are there not some harbour dues—some income derived above the bridge?—That is for what is called the Lower Navigation, between here and Lewes; it is a distinct part, to keep up their banks.

Do you know what is the amount of it?—No.

William Stevens.

18th May, 1844.

Is there any part of that money taken above the bridge applicable to the improvement of the lower part of the harbour?—No.

How many commissioners are there?—Quite 50, I think.

Do you know if the Act of Parliament makes it compulsory on them to have a reserved fund?—No, I am not in possession of that.

What number of vessels have you known at any one time in the harbour?—I have seen 30 sail at a time.

After your long experience here, what are the greatest improvements of which you think the harbour is susceptible; and what could be done to improve the interior of the harbour?—Nothing could be done to improve the interior of the harbour further than dredging the bottom and removing the banks.

(*By Sir Howard Douglas.*) You said that the roadstead opposite the harbour is not so good as in Seaford bay?—It may be rather better clay there in spots than off Newhaven.

You think that the enlargement of the inner harbour to the eastward would not be required by the trade of the town?—Not by our present trade.

But would not the enclosing of Sleepers' Hole be convenient to the trade?—We have no trade here that lies in the docks; they want dispatch.

Then you think the great object of any improvement contemplated here would be for shelter?—More for shelter for the whole Channel shipping in bad weather.

And that would depend upon the harbour of refuge and the safety of the roadstead?—Yes.

And upon its capacity?—Yes.

Have you thought of the length of breakwater, and its position in depth of water, that would be requisite to make a roadstead of sufficient capacity to be really generally serviceable to the country as a harbour of refuge?—Yes.

What length of breakwater?—I should think a mile and a quarter. My notion was to extend the pier or breakwater from Fricker Rocks in a southerly direction out into deep water, curving eastward at the south end in not less than 7 or 8 fathoms; and I do not think of any other pier being required in an east and west direction.

Looking at the plan before you, and carrying out your breakwater in one line to 6 fathoms, would you, in addition to that, propose the breakwater to be extended, and in what direction?—I should fall into this direction, curving towards Seaford Head.

Do you think there should be an opening between the pier of which you speak and the south pier or the east and west pier?—That would improve it very much.

(*By Admiral Dundas.*) Between what points of the compass does the wind bring in the heaviest sea?—From the west, and between the west and W.S.W.

What is the common rise and fall of the spring-tides?—Some spring-tides 18, and some 21 feet.

What is the rate of the spring-flood, or ebb?—I am not acquainted with it; I should think about four knots, to the best of my knowledge; but I hardly know.

Would any alteration or improvement which you have suggested now or heard from others, ever make Newhaven Harbour accessible, even at half tide, for merchant-vessels?—Yes, with this exception, there is such a strong flood runs in, that vessels do not like to take the piers without a great deal of steerage-way and a strong wind.

With the prevailing west winds, why do you recommend Seaford, which is on the weather side of Beachy Head, for a breakwater, instead of Eastbourne Bay, which is to the eastward and to leeward?—Eastbourne Bay would be better than this bay, with the wind strong from the west; but with the wind from the east there is no protection at all.

But if you had got a breakwater to the east, would that be a better protection for vessels than a breakwater to the west here?—I do not think it would be always so good; we have got a better eastern side; they have got no eastern protection.

Do you remember, during war, English cruizers being often driven from the station at Beachy Head by heavy western gales?—Yes.

Are you acquainted with the power of steam-vessels?—No.

Do you think a powerful steamer could keep the station off Beachy Head by anchoring in heavy gales from the eastward in Seaford Bay, and in western gales in Eastbourne Bay?—She would require more shelter if the wind came from the south; she must get under way.

Then taking all that into consideration, the protection of the coast and the protection of the trade, on which side of Beachy Head would you recommend a breakwater to be made, throwing overboard Newhaven?—Why this, I think, under present circumstances, would be the best. We only want one side to our bay, and they want two sides.

(*By Captain Fisher.*) Could ships sail from this harbour bound to the eastward or to the westward as they might require, with all winds that would enable them to proceed on their voyage?—I think they could if this breakwater were carried out.

Would vessels from the harbour in question reach round Seaford and Beachy Head with a wind that would take them from thence to the South Foreland?—Yes, unless in extreme weather, when it blew a gale from the south.

Do you see any difficulty to vessels seeking shelter in this harbour in heavy gales from the westward?—Not any.

William Stevens.

18th May, 1844.

What would be the consequence to a vessel so seeking shelter in a strong south-wester, if she should fail to get the harbour?—I cannot think she could fail if the breakwater were carried out.

What is the general feature and quality of the ground within the limits of the proposed breakwater, and do you think it is better than Seaford Roads?—I do not think it is better; but I do not think it is worse.

What would be the general set of the tide through this bay to Beachy Head if the breakwater were built?—It would change the set of the tide a good deal; but I should say nothing disastrous, or likely to do an injury. It would make less tide, I think.

(*By Sir W. Symonds.*) Have you tried the depth and the nature of the bottom yourself, or do you give your evidence from supposition, or from the evidence of others with regard to the ground within the proposed breakwater?—I think I must have rode hundreds of times in all gales of winds in the bay, and I never found bad holding-ground.

Have you sounded all over it?—No, I never sounded; but I have anchored in it hundreds of times.

(*By Sir Byam Martin.*) Let me ask you at what period did you correspond with Mr. Alexander, the architect, on the subject of improving the harbour?—I should think about 30 years ago.

Was it Mr. Alexander's opinion that there ought to be a breakwater?—He always thought it a place for improvement.

Was it his opinion that there ought to be a breakwater?—No, he never proposed a breakwater at all. I endeavoured to draw his attention to it, by a pencil sketch.

[*The Witness withdrew.*]

Captain Sir *Henry Shiffner*, Bart., R.N.

Captain Sir *Henry Shiffner*, Bart., R.N., examined.

Are you one of the Harbour Commissioners?—I am.

How long have you been so?—For a number of years.

Fifteen or twenty?—At least, but I have had very little opportunity of attending the meetings until lately.

Have you given much consideration to the interior of the harbour of Newhaven?—I have.

Can you suggest any particular improvement in the interior?—I can suggest nothing beyond what is in that paper which I drew out and sent to the Admiralty, and to you, Sir.

It is here, perhaps you will read it,—(*The paper was then read.*)—*See Appendix.*

Is the groyne-work you are at present about intended to be carried out 500 feet?—It is almost that distance now; it will be 500 feet when completed; it wants but 15 or 20 feet to complete it.

Why do the Commissioners stop short at 500 feet?—That was the distance suggested by Mr. Walker; it was the most economical plan suggested of the three proposed by him. I produce Mr. Walker's report.

Do you not think it would be a considerable improvement to extend it 1,000 feet?—I think it would; but in that case it should have been further from the west pier; that its outer end should not bear much to the south of its present bearing, or it might interfere with ships leaving the port with easterly winds.

Do you think the Harbour Commissioners would have any objection on account of the expense?—I do not think the Harbour Commissioners at present would sanction it from their funds, because there were three meetings held before they would sanction even the present work; there was great opposition, and the present groyne was only carried by a majority of two.

What ground of opposition could there be to it?—They very much doubted its being of any advantage.

But is it not generally understood that extending piers or groynes into the sea must be for a time a protection to the mouth of the harbour?—For a time certainly, but the opinion was that after a certain time so large a collection of beach would take place that it might fall over the groyne and become injurious to the harbour by blocking up its entrance.

Have you any knowledge of the quality of the bottom in front of the harbour?—I have never sounded in front of it.

Do you believe that the anchorage between the Fricker Rocks westward and fronting the harbour is as good as it is towards Seaford?—Certainly not, it is broken ground.

If you were called upon to fix the position of a breakwater in this neighbourhood, where would you place it?—I should place it to the eastward of the harbour's mouth.

Captain Sir *Henry Shiffner*, Bart., R.N.

18th May, 1844.

How far to the eastward?—In point of distance I should have difficulty in stating. I should say to enclose the best anchorage off Seaford, and in about eight or nine fathoms water.

If you were to place a breakwater where you describe, would you have a breakwater also running in a direction from Barrow Head, seaward?—Yes.

Why do you prefer placing it in the situation you have mentioned, is it the better quality of the bottom?—Because of the better quality of the anchorage within it, the ground is a stiff, blue clay.

Now I would ask you, as a seaman, and forgetting for a moment that you are a Commissioner of Newhaven Harbour, at what position between the North Foreland and Portland would you propose as best for a squadron of men-of-war, and particularly men-of-war steamers, to give protection to the entire trade of the Channel, and as a harbour accessible at all times of tide, day and night, to the trade of the country?—If I were to pass eastward from St. Helen's, I should unquestionably fix upon Seaford Roads.

By saying if you pass to the eastward of St. Helen's, was that in reference to Portland?—In dividing the distance.

What place between the North Foreland and Portland?—I should prefer Portland to any.

Then, coming eastward, which place do you think the best?—Seaford.

Suppose you were running in a heavy south-west gale and hazy weather, which would you feel, as the captain of a ship, was the most satisfactory, to pass round Beachy Head to find shelter on the other side or to find a breakwater at Seaford Bay?—That would very much depend upon the character of the breakwater; if it were such a breakwater as I should feel confidence in, I should prefer Seaford Bay.

Suppose the marsh-land to the eastward of the harbour converted into a basin, should you think that a great benefit to the trade of the country?—Very great indeed.

Would you prefer that to the smaller accommodation in Sleepers' Hole?—I should, but if Sleepers' Hole would afford a sufficient space, you are more under shelter in Sleepers' Hole, and that would give it an advantage. Sleepers' Hole would afford space for a basin of five acres, and there would be sufficient room at each end for dry docks.

Looking to the possibility of its being required for the accommodation of a large steam squadron?—I should then prefer it to the eastward, there being much greater accommodation.

Should you consider in that case it would be desirable to turn Sleepers' Hole into a harbour for sluicing, supposing you had a basin on the other side?—It would be of service certainly; it would be worth clearing out for that purpose.

Is it your opinion, as one of the Commissioners, that it would be advantageous to lengthen out the piers seaward?—Decidedly so, I have always been of that opinion, and have frequently advanced it at meetings of the Commissioners.

Is that the prevailing opinion among the Commissioners?—I do not think it is, I believe there are many who would oppose it.

But if it should be recommended by the Government, do you believe that the Commissioners would give way and consent to what they should recommend?—I have no doubt of it.

And do it at their own expense?—I think they would go to a certain expense; I think it is probable that they might be induced to do it to the extent suggested by Mr. Walker, if recommended by the Government.

And to what distance?—130 feet in addition to the present piers. The extension of the west pier 130 feet in length to be solid to the level of high water, and the east pier to be solid to the level of half-flood and open above, the extension of the two piers being parallel, but each side set back 10 feet from the present line so as to add 20 feet to the present width of the entrance, which, on entering, would be a great improvement.

Can you tell to what depth of water the pier at 130 feet would bring it?—I cannot; I should think not a very great depth. My reason for leaving the upper part of the east pier open, as suggested by Mr. Walker, is, that when the sea from the south-west passed round the western pier it would pass through the open work of the eastern pier and expend itself to the eastward, instead of rebounding, which it does at present, and makes the navigation very difficult. It would have another advantage, which I hardly think Mr. Walker had in view when he contemplated it: the last half-flood sets to the westward at the harbour's mouth, and the open work would allow the tide to pass through, and, meeting the western pier, the tide would run freer into the harbour It would throw a greater quantity of water into the harbour by passing through the open work and meeting the western pier; it would run truer into the harbour and prevent the tide being forced round as it is now. If you see it now, it strikes upon the eastern pier.

Do you consider it desirable that there should be a greater rush of tide than there is?—I think it would be an advantage to increase the flow of water into the harbour.

I thought it was an objection that there was such a rapid tide?—I do not think the flood-tide is of that force that there could be any inconvenience.

Do you think it would be an improvement on Mr. Walker's plan to carry it out further?—I think so, certainly into 12 feet at low-water spring-tides.

Captain Sir *Henry Shiffner*, Bart., R.N.

18th May, 1844.

(*By Mr Walker.*) Excuse me interrupting you, but in reporting that, I had it in view that I was reporting to Commissioners with limited means.

(*By Sir Byam Martin.*) I was going to ask the question whether the funds had not an influence on the report; but as you said before, if Government were to recommend the carrying it out further, you have no doubt the Commissioners would accede to it?—I cannot speak confidently upon that; I think they might,

How many Commissioners are there?—60 or 70 at least.

And what number are the effective, the managing Commissioners?—I should call 30 a large meeting. I think I have seen 30 upon the question of the present point.

Is it not likely to be inconvenient having so great a number of Commissioners?—Certainly.

Has party-feeling anything to do with these things?—I never knew meetings held at Lewes without party creeping in sooner or later.

Are many of the Commissioners, the managing Commissioners, proprietors along the banks of the river?—Yes.

(*By Sir Howard Douglas.*) Can you point out the position and extent of a breakwater enclosing that part of the roadstead which you think the best?—I cannot; I can only speak in general terms; I have not had a chart to refer to.

With respect to the harbour, whatever might be done afterwards, it would be necessary to improve this place, so as to make a sufficient dock to connect it with a harbour of refuge?—Yes, exactly; I look upon Seaford Bay as the harbour of refuge, and Newhaven as the harbour of refit.

(*By Admiral Dundas.*) Do you believe that any improvement now in progress, or that you have heard suggested, would ever make Newhaven harbour accessible at half-tide?—I should doubt that; you may get three or four feet more depth of water: when you say merchant-vessels you should say what size. For colliers and small vessels, with judicious management, I think it might be accessible at half-tide.

You have never sounded Seaford Bay?—I never have.

With the prevailing west winds, why do you recommend Seaford, which is on the weather side of Beachy Head instead of Eastbourne Bay?—Vessels, if they were to seek shelter in Seaford Bay, would be able to get to sea more easily than from the eastern side of the Head: I need not tell you that 19 out of 20 of the south-west gales in the Channel terminate with the wind shifting to the north-west; vessels then would be able to keep in smooth water down to the Wight, whereas by getting under way to the eastward of Beachy Head, they would still have the difficulty of rounding that point.

But the wind from the north-west is a fair wind out of Eastbourne Bay?—With strong W.N.W. winds, there would be a heavy sea setting round Beachy Head.

You remember, during war, English cruizers being often driven from their station at Beachy Head by westerly gales?—Yes.

Are you acquainted with the power of steam-vessels?—I am.

Could a powerful steam-vessel keep her station off Beachy Head, by anchoring in heavy gales from the eastward in Seaford Bay, or in western gales in Eastbourne Bay?—Though the greater number of gales in the Channel are from the south-west, it is generally admitted that the most disastrous gales are from the S.S.E.

I want to know if a steamer could keep her station without a harbour of refuge, under the different circumstances of steam and canvass; when we know that a sailing vessel could not?—A steamer could keep her station where a vessel under canvass could not; but at times the gales from the S.S.E. are so heavy that I think they would drive a steamboat in.

Such a harbour of refuge near Beachy Head would enable her to keep her station?—Decidedly.

(*By Captain Fisher.*) Have you any other reason for giving a preference to the westward of Beachy Head rather than to the eastward, than that the latter offers a greater facility to leave with a north-wester?—Yes; it divides the distance more equally between the Downs and Portsmouth; has a harbour close at hand (Newhaven) to run into in case of necessity; and has also better holding-ground.

I believe you have given as a reason that Seaford Road has a better anchorage than off Newhaven?—Yes.

(*By Sir W. Symonds.*) I would ask whether you have ever anchored under Dungeness?—I have.

(*By Sir Byam Martin.*) If we were to write to the Harbour Commissioners, to ask if they would be willing to the extent of their funds, to adopt such plan for the improvement of the harbour as might be recommended by Government, would they comply?—I think they would.

Can you state the amount of the income of the Harbour Commissioners?—The paper delivered in will show the amount.

Are the tolls above bridge applicable to the improvement of the lower part of the harbour?—No; they are collected under three different Acts of Parliament, the piers, the upper, and the lower navigation. The lower navigation is in a good condition as to funds, but the upper navigation is not in so good a state.

Then I would ask in what state are they with respect to the banks above bridge, to Lewes?—Remarkably good indeed.

And no encroachments?—No.

Supposing an encroachment to be made on the river, would the Harbour Commissioners at once interfere?—Most decidedly.

And would prevent it?—And would prevent it; they have the power under the Act of doing so.

Is it at any time asked of the Harbour Commissioners for permission to enclose?—I do not know of any instance of any inclosure being sought. Just above the bridge they have asked for posts for securing vessels, which have been granted.

If such an application were to be made, would the Commissioners feel themselves warranted in complying with it, without reference to the Admiralty?—I should think they might feel themselves justified in doing it, but I do not think they would do it.

In point of fact, would the Harbour Commissioners ever feel at liberty to permit any encroachment on the river without the consent of the Admiralty?—I think they would, but I cannot speak positively upon it.

Have any enclosures been made in this neighbourhood, on the banks of this river, within the last few years?—I really cannot say whether there have or not; I believe not.

(*By Mr. Walker.*) Is there any land which is under the level of high water which has been reclaimed or enclosed of late years?—I believe there is, but I cannot say in what part; I believe on the eastern side.

Can you tell me how long the marsh-land by the mill has been enclosed?—No, I cannot.

(*By Admiral Dundas.*) Have the Commissioners of the harbour received any rent for any such land enclosed near the mill?—I do not think they have received any.

What right has the miller, Mr. Catt, over the power of the water by his lease?—I do not know anything about his lease.

But, as a Commissioner, you are aware that no improvement in the harbour can be made without the concurrence of Mr. Catt, the miller?—Oh, no; I am not aware of that; I think there is a question as to whether the Crown has not a claim over that land. It has been suggested that the Crown has a power over the marsh-land on the east side.

Mr. Catt is a Commissioner himself?—Yes, and his son too.

I see a clause in your Act, "Commissioners to have no place of trust arising out of the duties;" has that been acted upon?—Yes.

Have any of the Commissioners rented land or houses under the trust?—I believe not.

Does Mr. Catt pay anything at all to the Harbour Commissioners?—I am not aware that he does.

Who is chairman of the Commissioners?—There is no permanent chairman; a chairman is elected when they meet.

[*The Witness withdrew.*]

William Cole, examined.

William Cole.

(*Chairman.*) What is your situation here?—I am carrying on general business as a merchant. I am agent for Lloyds and generally for the whole of the north country shipping clubs. I have had the command of a ship myself in the coasting and foreign trade. I have been a great many years at sea.

Have you any property over the way on the eastern side of the marshes?—On the eastern side, I have not.

Are you in connexion with Mr. Catt?—I am in partnership in the bonding stores, belonging to the port here; that is on this side of the water.

Do you know how long the land has been enclosed, the marsh on the east side?—Really I cannot say exactly as to the time, but it is within the last 15 or 16 years. I am only speaking from recollection.

Was it enclosed with the consent of the Harbour Commissioners?—I believe not; because, as I am one of the Harbour Commissioners, I know the thing has been very often brought forward by Mr. Blackman as to the enclosure of these salt-marshes, but they were considered the private property of Lord Sheffield, and disposed of by him to Mr. Catt.

Is it generally the case that the proprietors on the banks of the river think themselves at liberty to reclaim the land and enclose it?—There are certain boundary walls from the pier up to Lewes, and without those boundary walls the proprietors of the land of course claim it; but within these boundary walls the Commissioners of Sewers and the Commissioners of the Piers claim it.

Does the water flow within the boundary of these walls?—No; at spring-tides only it flows near the walls.

Then they do not take anything from the river?—No.

Do you think that the Harbour Commissioners would feel themselves at liberty to make enclosures without the consent of the Admiralty?—Decidedly not, I should say.

If any of the enclosures along the river were such as to diminish the back-water, would the Harbour Commissioners feel themselves warranted in granting the request of any

William Cole.

18th May, 1844.

landed proprietor to enclose there?—I should think not, the Harbour Commissioners, are very tenacious upon that point; and when I have been at the Commissioners' meeting, the Commissioners have generally felt very anxious about any enclosures; and I know that the enclosure of these salt-marshes has been a bone of contention from time to time. It has been a matter of doubt whether Lord Sheffield was justified in selling that property to Mr. Catt, but the question has not been brought forward. Mr. Blackman, one of the Commissioners, has given repeated notices, but it has never been brought forward.

How long have you been a resident here?—I have been a resident here for 34 years, and I have left off the sea out of that time 25.

Then, as a Harbour Commissioner, can you point out any improvement that you think would be desirable in the interior of the harbour?—I think I can point out a great many. In the first place I would state that we have a powerful back-water, and that the powerful back-water, in case the piers were both extended and widened, would be of sufficient force itself to deepen the channel considerably. And we have land both on the eastern and western side calculated to be excavated and made into floating docks for vessels, I should say of from 17 to 18 feet of water. When Captain Bullock surveyed this harbour, in Sleepers' Hole, he bored down and found nothing but blue clay for 17 feet.

Do you know of any borings outside the harbour?—No, but I have known vessels riding, and when the anchor came up it has been covered with blue clay, within two cables' length of the pier.

Have you ever seen vessels riding out in a gale of wind upon this shore?—I have seen vessels riding out gales of wind when they have been caught, and the wind has come from the south-west. I have known ships to part from their cables, but the anchors did not come home.

We will go back to the harbour; state what the improvements are?—I do not know that I can state any further improvement, only if the piers were extended the water might be deepened, and docks made on the east and west side, capable of receiving vessels of 16 or 17 feet water, and docks and patent slips for repairs might be constructed.

How far would you extend the piers?—They might be extended 400 feet farther into the sea with great advantage and made double their present width.

And, in fact, you mean that the farther they are extended the more will be the scour?—We go off with a sort of slope from our piers, and the power of the back-water is so great that if we were going out 400 feet further, and a breakwater to the westward was erected so as to prevent the beach coming from the westward, the powerful back-water would scour it down to low-water mark, which would give us three feet more than we have now at spring-tides. It would give us from 17 feet at neap-tides and 24 feet at spring-tides.

If we were to write to the Harbour Commissioners, of which you are one to suggest improvements for lengthening the piers out or in any other way, do you think that to the extent of their income they would be likely to comply with the recommendation of the Government?—I think the Commissioners would do everything that laid in their power to meet the views of Government.

But would they do it?—I cannot take upon myself to say that, for the Commissioners are a mixed body, of various classes and very numerous, and I really cannot say what they would do; I believe every disposition would be found on the part of the managing committee.

You find it practically inconvenient having so many Commissioners?—Decidedly so, and men unacquainted with the subject.

Now, as an old sailor and so long accustomed to this harbour, where do you think a breakwater might be placed with the greatest advantage?—I should recommend the breakwater being carried out off Seaford Head, eastward of the harbour.

How far is Seaford Head from the Pier Head at Newhaven?—About three miles; and then on the west side of the pier, I would recommend its being carried off above Woolmore Point.

(*By Mr. Walker.*) How far is that?—About a quarter of a mile.

(*By Sir Byam Martin.*) Then what you are now proposing is to embrace a space of three miles?—It embraces a space of three miles.

How far would you carry the breakwater off on the Woolmore Point?—I should say, if you carry the breakwater off Woolmore Point to enable ships of any burthen to ride under shelter in six or seven fathoms of water it must be carried off a mile or a mile and a quarter.

What is your object in proposing this sort of breakwater so extensive? Is it because of the quality of the bottom at any particular part, or not?—I think the bottom is good all over, as I have stated; I have seen ships get their anchors here not two cables' length from the Newhaven Pier covered with blue clay, and I believe the ground to be of the same description from Woolmore Point to Seaford Head.

(*By Admiral Dundas.*) You are in the Committee of Management. In what state are the funds?—I think we are now about 4900*l.* in debt.

Are the books of the Harbour Trust laid before the Quarter Sessions at Michaelmas every year?—No, they are not.

Have you ever brought forward any of the suggestions for the improvement of the harbour at the meetings of the Commissioners, and what has been the result of your endeavours?—I have since I have been in the commission. The first improvement that I was the means of bringing forward, with the assistance of Mr. Catt, was the extension of the eastern

William Cole.

18th May, 1844.

pier even with the western. Mr. Cubitt was the engineer. A committee was appointed to carry it into execution, and before that committee proceeded with it they thought it right to call Mr. Cubitt in to take his opinion upon the subject. That would be eight or nine years ago; he approved of it, and it was carried into execution. Before the extension of the eastern pier I have known the banks of beach alongside of the western pier to be so high that I have jumped over from the western pier upon the beach; and then, when the eastern pier was shorter than the western pier, of course when the water got down to the end of the eastern pier the scouring power of the water was done; it there expanded itself. And this bank of beach used to run out from the west pier in an easterly direction; and I have myself walked out upon the bank of beach sufficiently to the eastward to see up to the eastward side of the eastern pier; but when the eastern pier was extended even with the western pier, that brought the scouring power of the water down upon the bank of beach; and in less than 18 months after that pier was extended, where we had had 14 or 15 feet of beach lying along the western pier, pilot-boats lay afloat at low water. The extension of the pier was about 120 or 130 feet, at a cost of above 4000*l.*

Have you followed up any other of your suggestions?—The next thing that was suggested was the erection of the western groyne, westward of the west pier. I brought it forward, and was defeated in two instances, and gained it on the third; and it is now acting admirably well.

Are you acquainted with Mr. Catt's lease, and what power he has over the water?—No, I am not; but I can only observe that I do not think the enclosure on the part of Mr. Catt has been the least detrimental to the harbour; in fact, I think it has been beneficial.

Perhaps you will explain in what way?—Because, before these salt-marshes were inclosed, the tides flowed over them, and probably at spring-tides there might be 17 inches or two feet water; and at neap-tides they never were overflowed. The water used to drain off probably at first-quarter ebb, and then I conceive there is no scouring power; when water is at that height there is no scouring power going forward at the mouth of the harbour; but since these salt-marshes have been enclosed, the water has been compressed for the purposes of his mills, and let loose probably at two-thirds ebb; and then the water has come down in conjunction with the powerful back-water, and has assisted, in my opinion, in scouring.

Do you consider these salts the property of an individual or of the Commissioners?—I think the Commissioners cannot claim it, because Lord Sheffield has disposed of it; but on the western side it is doubtful. There are two bonding ponds for timber, and the Commissioners make the proprietors pay them a nominal rent to acknowledge that the Commissioners have a power over it.

Are you speaking of Sleepers' Hole?—Yes; the old harbour used to run in that direction, round Sleepers' Hole.

(*By Sir Byam Martin.*) No acknowledgment is paid on the other side?—No acknowledgment; in fact Mr. Catt has bought it, and claims it as his property.

(*By Admiral Dundas.*) With the prevailing west wind on this coast, why do you recommend Seaford, which is on the weather side of Beachy Head for a breakwater, and not Eastbourne Bay, which is on the eastern, and consequently the lee side?—I am not recommending our bay in preference to it for a westerly wind.

In the event of a war it would be necessary to have a harbour on this coast where steam-vessels could be sheltered from wind and weather, constantly ready to slip at a moment's notice, for the protection of the trade; to combine that object with a harbour of refuge for merchant-vessels, on which side of Beachy Head should such a harbour be constructed?—Why, I should say to the westward of the Head; we are naturally protected from easterly winds; the only advantage Eastbourne Bay has is with westerly winds.

By the Head?—Yes, by the Head; and therefore they would require a breakwater to protect them from easterly gales, as much as we should require to be protected by a breakwater from westerly winds. Then, on the other hand, I should say as a harbour of shelter, with a wind from the S.S.W., blowing a hard gale, after you get to the westward of the Head, ships could hardly clear the land upon either tack; therefore that renders a harbour of refuge decidedly necessary on this side of the Head. Then, on the other hand, I think it is more central between the Downs and Portsmouth.

Which is the prevailing and most tempestuous wind on this coast?—From the W.S.W.

Then, as a sailor, supposing the two breakwaters, one at Seaford with a protection from the west gales, and another at Eastbourne protected by the land on the west and by a breakwater on the east, which of these two would you take shelter in in a heavy gale?—If there was a breakwater of the description you name to the westward of Newhaven Piers that I could take shelter under, I would decidedly come here in preference to going round the Head.

Is there any reason for your dislike to go round Beachy Head from the fear of the Sovereign and other shoals?—There are the Boulder Banks and other shoals which I should dislike. I should go within the Sovereign Shoal.

Have you ever sounded on this side of the Bay?—I have sounded this Bay many times, and I have been riding there many times.

(*By Sir Henry Pelly.*) Supposing a breakwater which would protect vessels from wind to be erected on the east side, and one on the west side of the Head, and

William Cole.
——
18th May, 1844.

you are seeking a harbour of refuge in consequence of a heavy westerly wind, being bound to the westward, whether would you take shelter in the one at the east or the one at the west?—If I could gain the advantage of the western one, I should take it decidedly.

I am supposing that you are running up and off the Head, and the wind strong from the west, and you are seeking shelter, and there are harbours at both places, whether would you take the one on the eastward or the westward?—The westward, and then I should avoid those banks; and to the westward, I have regular soundings, and no shoals, and good sea room.

(*By Captain Fisher.*) Do I understand, speaking as a seaman only, and not with regard to the construction of the breakwater, but as a seaman going down Channel, and having got as far as Beachy Head, that if there were two harbours of refuge, one on the east and the other on the west, that you would prefer seeking the one on the west?—Decidedly so.

Now I would ask whether you do not conceive that in running to the harbour on the west that you are placing your ship in greater difficulty than if you ran to the eastward, supposing them to be equally good?—I think, not so much.

In making one to the westward, do you not necessarily make the land to the westward of that harbour?—Yes.

In making the land to the westward of that harbour with a westerly wind, would you not have a difficulty if you were obliged to sail for, and not able to round Beachy Head?—I should say that nine times out of ten you would make the western land better than you would Beachy Head.

Then, I ask again, supposing your ship was in any difficulty in making the harbour to the eastward, have you not the sea open, and you can place the ship in perfect safety?—Decidedly so, I should say more so to the westward of the Head than to the eastward.

But I ask, if by an accident you were prevented getting into the harbour, would you not, in reaching the westward, place your ship in great danger and difficulty; in making your harbour to the eastward you would have room to drift, and your ship would be in safety?—I conceive that if it were thick weather, and I could not make the land properly, and I wanted to make use of the western harbour of refuge, I should think myself in a better position to the west of the Head than I should to the east of it; and I should decidedly take the western in preference to the eastern as a port of safety to run for.

(*By Sir Byam Martin.*) Would you state what is the revenue derived from this harbour?—I have put in a letter from the clerk which gives the revenue for the last seven years, from 1836 to 1843, and that includes everything.

Are the tolls above bridge applicable at all to the pier?—Not at all.

(*By Lieut.-Col. Alderson.*) How long have you been agent for Lloyds, and which side of Beachy Head has the greater number of wrecks taken place during that period?—I have been agent 13 years, and the greater number of wrecks have been on this side than the other; but that has decreased very much since the erection of Beachy Head light. I succeeded Mr. Stone, who was comptroller of the customs here and agent for Lloyds, and during the time that he was agent here there was property lost between Beachy Head and Newhaven piers to the amount of 600,000*l.*, and Lloyds have proof of that.

Can we obtain a proof of that?—I cannot furnish it; Mr. Marriott was chairman at Lloyds at the time, and the amount was forwarded to Lloyds by Mr. Stone.

Will you state the dates that you are speaking of?—I have been agent 13 years, and my predecessor was agent about 13 or 14 years. There is only one thing I would wish to observe as regards this harbour and Shoreham Harbour; I am agent for five clubs that ensure mutually among themselves ships to the amount of one million of money, and they allow ships of 450 tons, without any extra average, to come into Newhaven; but if they go to Shoreham with above 200 tons, they are subject to 7½ per cent. extra average.

(*By Admiral Dundas.*) To what do you attribute your decrease of trade here?—I attribute it in a great measure to the railroad. I can only tell you, in one article I have a vessel constantly in the Rotterdam trade, and we paid about two years ago 4000 guineas duty on Dutch cheese; it is now about 2,500, and I attribute the decrease in the revenue to the communication Lewes has with the line of railroad from Brighton and London, by which goods are brought.

I see the number of vessels from foreign parts in 1841 was 91, and in 1843 it was reduced to 22?—That was in consequence of the making of the Brighton railroad. Out of those foreign vessels we had 70 or 80 coming from Caen with stone for the viaduct, and there was a great consumption of timber. That was the largest revenue we ever received at this port.

Are you likely to have a railroad to this port?—I am not aware of it.

What is the distance of the proposed line of railroad through Lewes, to Newhaven?—7 miles.

Are you likely to have that?—I think there is very little doubt of it.

[*The Witness withdrew.*]

Lieut. *Fothergill*, R.N., examined.

Lieut. *Fothergill*, R.N.

18th May, 1844.

(*Chairman.*) State what you are?—I did command the "Stork" for three years on this station; I am not in command of one at present. The "Stork" was on this station cruizing between Newhaven and Dungeness; and I have been 7 years cruizing in the Channel.

Were you often at anchor in this bay?—Very frequently in this and Seaford.

What difference is there in the quality of the bottom between Seaford and Newhaven?—Seaford is stiff blue clay, and considered better holding-ground than nearer Newhaven.

We have been told, by a person who has been accustomed to anchor fronting Newhaven, that his anchor has come out with stiff blue clay upon it?—There may be spots of that kind; I do not consider the holding-ground good.

But the general character of Seaford Bay is better than the front of Newhaven?—Certainly.

How often have you anchored at Seaford?—A hundred times.

Did you ever anchor there in blowing weather?—I generally anchor there with an east wind.

How many times off Newhaven?—Thirty or forty times.

And speaking with that experience, you say the anchoring-ground off Newhaven is not so good?—Not so good holding-ground as off Seaford.

But should you describe it as a bad holding-ground?—No, I should not call it a bad holding-ground.

And after your long experience on the coast as a cruizer, if you had to name the position where there should be a harbour of refuge, would you prefer it on the west side, or the east of Beachy Head?—I think the east would be more easily obtained. You can work to the westward easier; it is more difficult to work round Beachy Head; but at the same time, the Seaford Road is better. I have seen 200 sail lying at anchor in Seaford but had the wind come in south, not one-half of them could have worked off shore.

The question is, which would you prefer, suppose you were to have an artificial harbour constructed, which would you prefer, the east side or the west side?—I think the east side would block up.

But suppose a harbour were to be constructed, which side of the Head is best, the most convenient for the navigation of the Channel?—The west side; because the homeward bound ships and others cannot work round Beachy Head against an east wind; and there is no safe anchorage with that wind (not even in the Downs) when up past Beachy; consequently the trade-ships anchor in Seaford Bay, or work about the Channel at the risk of being wrecked on the coast of France; but were there a refuge harbour in Seaford Bay, they would be safe in all winds, and protected from an enemy in time of war; as there would be water for the largest steam-frigate, or even a line-of-battle ship, and with excellent holding-ground.

(*By Admiral Dundas.*) In the event of war it would be necessary to have a harbour on this coast where steamers could be sheltered from all winds and weather, constantly able to slip at a moment's notice for the protection of trade and the protection of the coast, to combine that object with a harbour of refuge for merchant-vessels, on which side of Beachy Head would you construct that harbour?—On the west side.

(*By Captain Washington.*) Have you any objection to state your reasons?—I think, in the event of a war, Seaford Bay, as a place of refuge with an east wind; but if the wind came from the south, they would not be able to work off shore. I think at least 100 out of 200 would come on shore; if there was a harbour of refuge at Seaford, they would not have occasion to move with a south wind; if the harbour of refuge was at Newhaven, they would only have occasion to get under way and enter it.

(*By Admiral Dundas.*) Are you acquainted with the power of steam?—Not much.

You remember that, during war, cruizers were driven off this station by westerly gales?—Yes.

Do you consider that a powerful steamer could keep her station off Beachy Head by anchoring in western gales in Eastbourne Bay, and in eastern in Seaford Bay?—Eastbourne Bay is bad holding-ground.

In Eastbourne Bay could she find shelter from the west?—I do not think she could; she could not lie there for a moment should the wind come to the southward of W.S.W., the holding-ground is so bad. I am not speaking of Langley Point.

But you consider the ground in general bad to the eastward of Beachy Head?—Yes.

(*By Captain Washington.*) Do you think the shoals within the Royal Sovereign Shoals are any objection to an asylum harbour to the eastward of Beachy Head?—I do.

[*The Witness withdrew.*]

Lieut. *Hemer*, R.N.

18th May, 1844.

Lieut. *Hemer*, R.N., examined.

(*Chairman.*) State what you are?—I command the "Lively," revenue cruizer, and have commanded her since July, 1839.

At what station?—The first 12 months I was stationed on the flats close up to Sheerness. I came to sea in this vessel in September, 1840, and have been cruizing between South Foreland and Hastings.

Have you been in the habit of coming round the Head?—Only making a voyage from Hastings to Portsmouth.

Which situation do you think most eligible for a harbour to be made, on this side of Beachy Head or on the east side of it?—I should say at Langley Point.

And what are your reasons?—Because there is deeper water close to the beach there than there is here.

Perhaps I should explain to you, that the object of the harbour is for the accommodation of a squadron of ships-of-war, the largest steamers, for the convenience of the trade in general as a port of refuge; for this purpose, which do you consider the most convenient situation, bearing in mind as a port of refuge also for the trade?—Why I mention Langley Point is, that I do not conceive that vessels can always reach Newhaven; vessels very often reach Eastbourne and get a flood-tide. They cannot get round Beachy Head with a westerly wind.

You must bear in mind, when we are speaking of ports of refuge we are speaking of a port of refuge for vessels whether they are bound up or down Channel, and to be accessible at all times of tide?—I do not see that there could be much difference in the two places.

And do you consider it best holding-ground on this side of Beachy Head or the other?—This side, Seaford Road.

(*By Admiral Dundas.*) Suppose a merchant-vessel lying under a breakwater in Pevensey Bay, in a severe gale from W.S.W., it veers round to the north-west, will she clear Beachy Head?—Yes.

If you were five leagues to the west of Beachy Head, and a stormy night coming on with rain, and you had it in your power to choose an anchorage under a breakwater off Seaford, or another in Pevensey Bay, which would you go to?—I would go to neither.

But suppose you did go to one?—I would go to the one in Seaford.

Why would you go to neither?—I would rather go to Dungeness Road.

And would prefer Seaford to Pevensey?—Yes, because there is better holding-ground.

But when you were asked a question just now where you would construct a harbour, you said Langley?—Yes, supposing there was to be a harbour only, not for a breakwater.

(*By Admiral Dundas.*) In the event of a war, it would be necessary to have a harbour on this coast near Beachy Head, where steamers could be sheltered from all winds and weather, constantly ready to slip at a moment's notice for the protection of the trade and the defence of the coast. To combine that object with a harbour of refuge for merchant-vessels, on what spot on either side of Beachy Head would you form a harbour?—Then I would say the west side. I said Langley Point as a harbour only, but I did not understand a breakwater outside it.

(*By Sir Byam Martin.*) Would you prefer having a harbour in Seaford; I am speaking still of a harbour to be constructed, and a breakwater, at Seaford or Dungeness?—If you could construct a harbour, I prefer Dungeness.

Why?—I have often seen 200 sail go from Dungeness, and half of them come back again not being able to get round the Head against a flood-tide.

(*By Captain Fisher.*) Supposing that such a harbour as has been described to you is to be constructed, accessible at all times of tide and all circumstances, anywhere between the North Foreland and Portsmouth; where would you prefer its being constructed for the trade generally, and for armed steamers?—I am so little acquainted with this part of the coast, I cannot say.

(*By Mr. Walker.*) If you know between the South Foreland and Dungeness well, what is your opinion of Dover for the purpose named?—I should not like it.

Why?—Because you cannot get into Dover at all times.

(*By Sir Byam Martin.*) Suppose a harbour built round Dover?—It is bad an chorage in Dover. I do not like the beach; that is, as it is now.

Why is it bad?—It would be as good a place as any other if a harbour was made there. If a harbour was made there, I would as soon take a vessel into it as into Dungeness Roads.

(*By Sir W. Symonds.*) Should you think it as safe for the anchorage in it as Dungeness?—No, I should not; I would rather anchor in Dungeness than in any other place on the coast.

[*The Witness withdrew.*]

Lieut. *George Franklyn*, R.N.

Lieut. *George Franklyn*, R.N., examined.

(*By Captain Washington.*) You are on the Coast Guard?—I was at Newhaven four years and a half in the Coast Guard.

During the time you were in the Coast Guard, had you any opportunity of ascertaining the nature of the holding-ground?—Yes, I have been in Seaford Roads when

vessels could hardly get their anchors. There is great difficulty, it being a strong blue clay.

Lieut. *George Franklyn*, R.N.

18th May, 1844.

(*By Sir Byam Martin.*) What do you say of the road to the westward?—The ground is not so good; when you get a little way to the westward of the piers, fishermen are obliged to haul their trawls up there.

(*By Captain Washington.*) Did you assist Captain Bullock in his borings?—Yes, I was with him once, and lent him all the assistance I could.

Did he bore at all outside the harbour?—Not to my knowledge; he bored a great deal where he thought there would be a good place for docks.

State what advantages Newhaven possesses over other pier harbour?—The advantage Newhaven Harbour possesses in gales from the S.S.W. to west is that the tide makes westward in the bay shortly after half-flood, consequently vessels taking it in bad weather have not that difficulty there is at Dover and Ramsgate, where the tide runs rapidly past the piers to the north-east.

Is there not rocky ground close in shore in Seaford Bay?—I have fished over the whole of Seaford Bay, and have found a clear ground with a slight coat of sand over the clay.

[*The Witness withdrew.*]

WEYMOUTH.

Tuesday, 28th May, 1844.

Sir T. Byam Martin, in the Chair.

Lieutenant *William Marshall*, R.N., examined.

Lieut. *W. Marshall*, R.N.

28th May, 1844.

(*Chairman.*) What vessel do you command?—The "Adelaide" revenue cruizer.

How long have you been on the Portland station?—Seven years.

Have you ever served in square-rigged vessels on this station?—No.

Have you been often in during the night?—Frequently.

And without any apprehension as to danger?—The Shambles offer the principal danger.

Is the Race very dangerous at night; is the danger increased by it?—Yes, and should be avoided in blowing weather.

Do you think if a breakwater were made here, as shown in plan No. 5, that merchant-ships would run any risk in running in during a gale?—None, not even at night.

Have you found that in south-west gales that the gusts are strong off the land?—Yes, off Portland.

And what distance off do they reach?—About a mile.

Have you known many vessels in easterly winds go ashore?—Yes, several; not more than three or four at one time; not more than ten altogether.

Do you think that if there were a breakwater, vessels would go into the West Bay in an easterly wind, or prefer the protection of the breakwater?—I should say they would prefer the breakwater, because, if the wind were to fly round to the southward, they would get embayed on the west side.

Have you known vessels get embayed there?—Yes, several; and all hands perished.

Do you know Portland as a holding-ground?—Yes.

What sort of bottom is it?—Three different strata of clay; the inside, in about five fathoms, blue clay; the outside not so good, but still clay.

What is the general character of Portland as a holding-ground?—Good; but much injured by vessels throwing ballast overboard.

Have you any idea of the number of vessels that frequent Portland during the year?—No; it depends on the demand; but I should say about 300 or 400.

And they all throw their ballast overboard?—They do always in the Roads.

Has any person a control over the Roads?—Yes, the Trinity Commissioners. The Collector of Customs is one.

Have you ever heard of their interfering to prevent ballast being thrown over?—No.

Have you heard, as a common observation, that the Roads are thus much injured?—I have.

Suppose a breakwater were constructed, do you think a passage for exit and entrance between it and the shore would be desirable?—With wind at the north-west, I do; but for general purposes, I do not; meaning, that should a vessel part in a north-west wind, she could then get out in place of running on the breakwater.

Suppose a vessel coming in with a south-west gale, could she anchor in the bay, not being able to get round the breakwater?—She must run in to Weymouth Roads.

Would vessels coming in at night go to the east of the Shambles?—It would depend whether they were acquainted with the passage between the shore and the Shambles.

What are the bearings for knowing when you are round the Shambles?—Wyke Church just open with Portland by day, and at night keeping from two to three miles off, until the lower light bears north-west and by west.

How do you know when you are sufficiently to eastward of the Shambles to bear up?—Judging by the distance from the lights.

Would not that be likely to convey vessels too much to leeward in south-west gales?

Lieut. *W. Marshall*, R.N.

28th May, 1844.

—No, with a south-west gale they would go several points free. It is quite smooth under the Shambles.

(*Sir Howard Douglas.*) If there were an opening and a harbour light, would not that with the Portland light give a safe direction for entrance?—I think it would.

(*Admiral Dundas.*) Do you think an opening should be left for small craft and boats?—It would be convenient for the fishermen especially.

From the set of the tide out of the bay, a passage 100 feet wide would enable the stone-vessels to work through?—There is but very little tide in Portland Bay; it runs nine hours ebb, and it would depend upon the weather.

You are then rather in favour of an opening?—Yes, certainly; for small vessels, but not for large, as the winds any way to the southward or westward are very baffling.

(*Chairman.*) You said that an opening was only necessary in case of vessels getting away from their anchors in north-west winds, and that otherwise you appeared to infer that there was no great advantage, do you know of any disadvantage?—No, none.

(*Sir Henry Pelly.*) Have you ever known vessels part in north-west gales?—Never part; but I have known them drive, being short of cable.

(*Captain Fisher.*) Would a western entrance much facilitate vessels, particularly in fleets outward bound, leaving the harbour with wind at east, and thus enable them to make their passage to sea and down Channel quicker than otherwise?—No, the wind would be right on; consequently, there would be a heavy sea, and attended with danger, as the land at Portland runs south-south-east.

Supposing only one entrance to the north-east, would not vessels in strong south-west and westerly winds be obliged to run far to leeward, and thus only reach the lee part of the harbour?—No, I consider they could come round the breakwater, and make a tack in.

In running in for shelter with wind strong from west-south-west and west, would vessels come to leeward of the Shambles?—Yes, I think they might; but they would sooner avoid it.

(*Sir William Symonds.*) Do you not generally find the wind baffling near high lands?—Yes.

Suppose the wind to be at east, and a heavy-laden merchant-vessel having to work out of the west or inner passage, would she not, on getting outside, find a lee-shore on Portland, on the larboard tack, and the breakwater itself on the starboard?—Yes, she would.

How does the east end of the Shambles bear from Portland Roads?—South-south-east, half east.

Would not a western passage, if broad enough for ships to work through, expose vessels to a heavy sea and wind when blowing from south and east-south-east, in that part of the Roads best adapted for small merchant vessels, where, I think, you say the best holding-ground exists?—At south-south-east, the sea does not come in, because the Shambles in a measure offers a protection, but at east-south-east it would be unsheltered.

(*Mr. Walker.*) What is the least depth at low-water spring-tides on the Shambles?—I have never come over less than three fathoms.

The lift of tide being nine feet at springs, you have four and a-half fathoms at high-water springs?—Yes.

You said before that, inside the Shambles in south-west winds the water was smooth?—Yes, it acts as a breakwater.

What winds, at present, are the Roads most exposed to?—From south-east to north-north-east.

(*Admiral Dundas.*) In time of war, in the present state of Portland and Weymouth Roads, could a fleet of men-of-war and armed steamers rendezvous there in all winds and weathers; or would it be beneficial to the objects I have stated, to have a breakwater made in Portland Roads?—I think that, as at present they would run a risk, a breakwater would ensure this object at all times.

Suppose a ship anchored under the proposed breakwater in a west-south-west gale, and the wind flew round to the northward, would it not in such a case be difficult for that ship to get sea round the north end of the breakwater, and would not a passage towards the south end be most useful?—Yes.

(*Captain Fisher.*) Would the wind at east enable a ship to sail from such a harbour through the western passage, and weather round Portland, when she could not work round the north end?—No, I consider that there would be a great risk, as Portland would be a lee-shore.

(*Chairman.*) Suppose a breakwater to be formed with an opening in the middle, would not that obviate all the difficulty or inconvenience you mention with respect to a lee-shore, with the wind at east?—Yes, I think it would.

With reference to a former answer you gave, is it not likely that ships at night running in for Portland would go in between the Shambles and Portland rather than go to the eastward?—It would depend whether they were acquainted with the coast or not, as in blowing weather the Race and Shambles frequently meet.

[*The Witness withdrew.*]

Mr. *Lowe*, Chief Mate and Commander of the Revenue Cruizer "Petrel," examined. Mr. *Lowe*.

28th May, 1844.

(*Chairman.*) How long have you been on this station?—Eight years.

Are you in the habit of coming into Portland Roads?—Yes.

You always approach at night without fear?—Yes.

Would you in a large ship?—Yes, if clear weather.

Do you think in south-west gales outward-bound vessels would take shelter here?—Yes.

And do they so now?—Very frequently, by night and day.

What is the quality of the bottom in Portland Roads?—In six and seven fathoms it is good holding-ground; but nearer in shore, in four fathoms, it is not so good, in consequence of the ballast being hove over there.

How many vessels come in in ballast during the year?—I should say 200; and they all throw over their ballast as a regular practice.

Have you ever known any remonstrance made?—No.

Is there any harbour-master?—Not in Portland, but in Weymouth there is; Mr. Terrard is harbour-master there.

What is the quality of the holding-ground in Weymouth Bay?—Good; as good as Portland.

Have you ever rode out a heavy gale in Weymouth Roads?—No; when it blows from eastward we beat out.

Have you ever rode out a gale in Portland Roads?—Yes; in all weathers.

Have you ever known vessels part in Portland Roads?—Yes; one winter, seven years since, three went ashore; they were stone-vessels.

Have you known many vessels anchor in the West Bay or Chapel Cove?—Yes, many.

Have you known instances of the wind coming round on them when anchored there, and what was the consequence?—They all got out; none went ashore.

Suppose a passage between the shore and the breakwater, would it be a convenience for the trade as an exit and entrance?—Yes, it would.

Are the squalls heavy off Portland in south-west gales?—Yes.

Then that would be an objection to vessels going in?—Yes, it would; but an advantage to vessels going out, as they could then run out when the wind was from the north; when they could not beat round the north end.

(*Sir Howard Douglas.*) In running in from the westward with a strong south-west wind, would you run in between the Shambles and Portland?—Yes, I would; but in a large ship I would prefer running round outside.

Would you prefer running into the breakwater by a southern entrance, or would you go round the north end?—I should go round the north end, and get into safe anchorage at once.

(*Admiral Dundas.*) In the event of war, could a fleet of men-of war and armed steamers keep their station, as Portland and Weymouth Roads now are?—I think they could not in all weathers.

Would a breakwater enable them to do so in all winds and weathers?—Yes, it would so.

Do you think, for the convenience of small craft and boats, that a passage should be left between the north end of Portland and the breakwater?—Yes, it would be a convenience.

(*Sir Howard Douglas.*) If a harbour were constructed, would it be much frequented by the trade in easterly gales?—Yes, in any winds.

Would the Portland Roads be preferred, under these circumstances, to the West Bay?—Yes, certainly.

(*Chairman.*) Which would you prefer, an opening in the middle of the proposed breakwater or on the south end?—In the middle, as giving more shelter for small craft in shore.

(*Captain Fisher.*) Are you of opinion that a small entrance on the westerly end of the breakwater would enable ships to leave the harbour in fresh easterly winds when there might be a difficulty in their getting out at the north-east end?—Yes.

Would not ships going through this western passage with the wind at east be enabled to fetch round Portland and run down Channel?—Yes; but with the wind to the southward of east.

(*Sir William Symonds.*) Looking at the chart, and considering the wind from east-south-east, would you in your cutter, or any merchant-vessel, at night time, go out by a narrow inner passage between the breakwater and the shore, or would you hug the lee or west side of the breakwater, standing to the northward and tacking round the north end of the breakwater?—In my cutter I should not hesitate; but in a merchant-vessel I should go round the north end of the breakwater.

Is not the wind generally baffling in the neighbourhood of high land?—Yes.

Does not the Race off Portland change its position sometimes and create doubt and embarrassment as to the passage between it and the Shambles, particularly to strangers, and when the tide is running to the eastward?—Yes, it does, and occasions difficulty.

Would not a southern or inner passage allow a heavy sea to enter and expose the inner harbour, where merchant-vessels lie, to damage?—Yes.

Mr. *Lowe.*

28th May, 1844.

What have you to direct you in coming in between the Shambles and the Race of Portland?—The Portland Lights; the high light open to the eastward of the lower.

(*Chairman.*) With reference to your observation that the southern passage would expose vessels in a south-south-east gale, would the middle passage have that effect?—I do not think it would.

(*Admiral Dundas.*) If there should be a second opening, where would you have it, between the south end and Portland, or in the middle of the proposed breakwater?—In the middle.

Would it not inconvenience the fishermen if there were no opening between the land and the southern end of the breakwater?—Yes, it would make a longer pull for them.

(*Mr. Walker.*) Have you much considered the subject of a breakwater at Portland?—Not much.

Have you ever heard of a passage between the land and the breakwater, or in the middle, before the present time?—I never have.

Comparing the advantage and disadvantage of having a passage, do you, on the whole, consider it an advantage?—I do; if there were to be one in the middle.

Of what width?—Sufficient for large ships under all circumstances.

(*Lieutenant-Colonel Colquhoun.*) Of what is the Shambles composed?—Of shingle.

Is it liable to any material alteration from shifting?—From my own observation, I cannot say.

[*The Witness withdrew.*]

Mr. *Joseph Read.*

Mr. *Joseph Read,* examined.

(*Chairman.*) What has been your occupation?—In the merchant service 30 years.

In what trade?—Coasting in the Irish trade chiefly, but belonging to Portland Head.

Are you a pilot for Portland Head?—There are no branch pilots.

Have you ever brought any large ships into Portland Roads?—I have.

Should you have any difficulty in bringing a large ship in in the night time?—No.

Supposing coming in in a south-west gale, would you come between the Shambles and shore, or to the eastward?—It would depend on tide; on flood I should come round the Shambles.

Are the marks for the Shambles the same as when you knew it 30 years since?—Yes.

Coming round the east end of the Shambles, what are your marks to know when you are to the east?—By the distance run.

What sort of bottom in Portland Roads?—Blue clay; good holding-ground.

In Weymouth?—Hard sand; not so good.

Have you ever known any vessels drive on shore in Portland in easterly gales?—Yes, many; I may say seven in one gale.

Do you think if a breakwater were constructed here, that the trade of the Channel would use it much as a refuge?—I do, certainly. Many ships beating down Channel as far as the Lizard and Start are obliged to try back for the Downs.

What is the greatest number of vessels taking shelter in S.W. gales?—Often from 60 to 70 at once.

Is it common at all times to see vessels coming in in S.W. gales?—Yes, in the winter particularly.

Do vessels often anchor on the west side?—Yes, when the wind is from N.E., but very seldom ships, only coasters.

But if a breakwater existed on the east side, it would be preferred, and much used?—Certainly.

Do you suppose much damage done to the Roads by ballast being hove overboard?—Yes, a great deal.

Has any person any authority to interfere?—I cannot say, unless the collectors may have.

Has this been always the custom?—Yes, ever since I remember.

(*Sir Howard Douglas.*) Vessels having taken shelter in Portland Roads in strong S.W. gales, and the wind flying round to E.N.E., or east, would not a merchant-vessel find difficulty in getting out?—Yes, great difficulty,

And that danger would be obviated by constructing a breakwater?—It would.

(*Admiral Dundas.*) Do you think a passage in the south end of a breakwater would be of great use to all vessels, particularly to small craft and fishermen?—No, I do not; very much against them.

Would you have any opening?—No, none at all.

In the event of war, could a fleet of men-of-war and armed steamers be able to keep their stations here, as Weymouth and Portland Roads now are, in all winds and weathers, and at all times?—I think there would be a great difficulty in getting out; but if there was a breakwater, they could get out at all times.

Supposing it blew very hard from N.N.W., and a ship could not get out, would she not be able to do so by a southern passage in breakwater?—No; I should not like to risk it; besides, such an opening would admit a heavy sea to the injury of small craft in the inner harbour.

You have stated your objection to an inner passage, have you any objection to a centre passage?—The force of the S.E. will send a heavy sea through, and disturb the inside of the breakwater.

(*Sir Henry Pelly.*) In your evidence you state that you have known vessels get as far down Channel as the Lizard, and return to the Downs when the wind came to blow from the south-west strong, can you state any reason for their not taking refuge in Portland Roads?—It must be owing to the darkness of the night, or being unacquainted with the coast.

That would be the same whether a breakwater were there or not?—Certainly.

(*Mr. Walker.*) Then you consider Portland Roads to be a safe refuge in south-west winds in its present state?—Yes.

To what winds is it exposed?—From east to south.

(*Captain Fisher.*) Would not an inner entrance give much facility, particularly to fleets outward bound leaving the harbour with the wind at E.N.E., and thus enable them to make a passage to sea and down Channel when they might not be able to go out by the north-east end?—No; they would go out by the north-east better; because by the inner passage you could not clear Portland.

(*Sir William Symonds.*) You consider that two miles or more of space between the north-east end of breakwater and the Weymouth coast ample room for vessels to work to windward when the wind is blowing fresh off the land, and consequently there is no sea of importance?—Plenty of room.

(*Chairman.*) How does the tide set from Weymouth towards Portland Head?—Directly across, for the north-east part of Portland after high water.

Do you know whether the sand in Weymouth Bay has been moved by north-west gales?—I think it has not.

What would be the effect caused by the proposed breakwater on the tide?—It would strike about the middle of breakwater.

At what rate does it run?—About half a knot.

Has the ground over which the tide flows at the back of the town been enclosed or embanked?—It has; about five or six years since.

Do you recollect Weymouth Harbour being dredged?—Yes, about three years since.

Has its depth increased?—I cannot say.

(*Captain Washington.*) What would be the effect of making an opening 100 yards wide in the Chesil Bank?—A very bad effect.

State your reasons for thinking so?—First, I think it would be almost impossible for any building to stand there, and I doubt the possibility of getting a foundation, as the water is so deep on the west; and, again, if a ship is ever caught in the west bay in a westerly gale, that no ship could run for such an opening.

Are you aware that the water on flood-tide is said to stand much higher in West Bay than in East?—Yes, I should suppose a difference of 5 feet.

With this difference of level and nine hours' flood, would it not tend to keep the passage open?—I think not.

Would it injure the town of Weymouth?—I think so. The tide would come in in such strength that the houses would be washed away.

(*Admiral Dundas.*) Are you well acquainted with the coast from Scilly to the North Foreland?—Yes, I am.

Which side of Beachy Head would you construct a breakwater for the advantage and protection of the trade, and to enable men-of-war and steamers to keep their stations in war?—I should say on the east side, about Eastbourne.

Did you ever anchor in Eastbourne?—Yes.

In Seaford Bay?—Yes.

If there were a breakwater in Seaford Roads to protect vessels from westerly gales, such as there is in Plymouth Sound, would you anchor under it, or would you prefer a breakwater in Eastbourne Bay, the land protecting you from the west, and the breakwater from the east?—I should prefer Eastbourne.

Should you have any fear in running for Eastbourne Bay of the Sovereign Shoal on the starboard hand, and the Hollowell bank on the larboard, at night or in thick weather?—It would be dangerous.

(*Sir Howard Douglas.*) Would it not be better, then, to have a breakwater in Seaford Bay, and avoid these dangers?—No; I prefer Eastbourne.

(*Chairman.*) Is not the ground at Eastbourne Bay foul as an anchorage?—It is hard ground; not good holding-ground.

Notwithstanding this, you recommend this as a breakwater harbour?—Yes, because it is shallow water.

(*Admiral Dundas.*) In the event of war, it would be necessary to have a harbour on the coast of Kent, between Beachy Head and the North Foreland, where steamers would be sheltered from all winds and weathers, constantly ready to slip for the protection of the trade and defence of the coast: to combine that object with a harbour of refuge for merchant-ships, at what spot on that coast could you say such a harbour should be constructed?—I should say Dover.

Do you know anything of steamers?—Yes.

Could a powerful steam-vessel get from Dover to Dungeness in a south-west gale?—Yes, I think so.

What are the Shambles composed of?—Shingle; the same as that at the Needles.

Mr. *Joseph Read.*
28th May 1844.

(*Captain Fisher.*) If a harbour were constructed at Seaford (west of Beachy Head), would you not in thick weather, not knowing where you were, keep out to sea in preference to running for such a harbour, blowing strong from the westward?—I should prefer keeping to sea.

Supposing the same harbour constructed to the eastward of Beachy Head, with the same weather, should you find the same difficulty in running for a harbour there?—I should not run for the harbour if I could not find my position by sounding or some other means.

(*Sir William Symonds.*) What do you think of the holding-ground in Dover Bay?—Good holding-ground.

[*The Witness withdrew.*]

Wednesday 29th May, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *R. White.*
29th May, 1844.

Mr. *Robert White*, examined.

(*Chairman.*) In what situation are you employed?—In the Packet Service.

For how long?—From 1806 to 1817, in the "Greyhound" cruizer; since that, commanding a packet. In 1805 I commanded a letter of marque.

Do you consider the anchorage in Portland Roads accessible at all times of night in blowing weather?—At any time.

Do ships coming in at night come between the Race and Shambles, or go to eastward of them?—The passage between the Race and Shambles is not to be taken in all winds; they go to eastward generally.

What do you consider the quality of bottom in Portland Roads?—Blue clay, with about six inches of sand.

In fact, good holding-ground?—It cannot be better.

What is the quality of bottom in Weymouth?—The same; very good.

Do you think much damage has been done to the Roads by heaving over ballast?—No ballast is thrown overboard except close in shore, and the first easterly wind throws it upon the beach, but not to the injury of the Roads.

But there appears no sign of this at present on Portland beach?—The vessels coming there now do not come in ballast; I speak of the billy-boys, flat bottomed.

We have been told by several persons that much injury has been done to the Roads by the heaving over of ballast; is it so?—I think not.

What is the greatest number of vessels you have seen in Portland Roads at one time?—During the war, with a convoy, from 100 to 140.

Did you ever know ships taking refuge here to be caught with an easterly gale?—Yes; ships coming in for shelter from a south-west gale, the wind has suddenly shifted to eastward, but they have laid there then some hours.

Have you known bad consequences?—No; never.

Is the West Bay much used by ships?—No, it is not, except in easterly winds; but on the first indication of a variable wind, they get under weigh.

Have you ever considered the subject of a breakwater at Portland?—Yes; I have been out on both surveys for the purpose, in 1822 and 1836.

Who were the surveyors?—Messrs. Bush and Dodd.

From your experience, which do you consider the best line for a breakwater?—Such as shown on the plan, about a north-easterly direction.

Suppose, then, a breakwater to be thus constructed, would you recommend any opening in it; and if so, should it be close to the shore or in the middle?—I would recommend no opening at all.

Does it blow hard frequently from the north-west?—It does.

Suppose, then, the breakwater to be one continued line, how would a ship in such a wind escape should she part from her anchors?—I think there would be no danger of her parting; but if she did so, she would be able to clear the north-east end.

What is your objection to an opening in shore?—That if a vessel takes that in going out with wind at east, she would not clear the land round Portland.

Would not an opening in the middle obviate this?—Yes; they would by that clear Portland, but at a risk.

Now suppose in a north-west gale, and a ship parting, would not an opening at once and without difficulty afford an escape?—Of course it would.

What is your objection to an opening in the breakwater?—Vessels running in for shelter from a south-east gale would take the north-east part of breakwater, and avoid the end, in preference to taking the opening, as there would be so much cross sea in the opening.

Suppose the 140 sail you have described as taking refuge in a south-west gale be found within the breakwater with wind coming from north-north east, would not the opening mentioned facilitate their getting out?—It would be of use in that case with so much shipping in, but the water would be smooth, and they could then work out with facility.

(*Sir Howard Douglas.*) Do you think such a harbour would be much frequented by the trade for shelter in peace, as well as protection in war?—Decidedly so. I have found many vessels in an easterly gale who would not come in to Portland, there being no breakwater.

(*Admiral Dundas.*) Is there much trade in stone and fishing in Portland?—There is no other trade.

Mr. *R. White.*

29th May, 1844.

Would it be a convenience to such trade to have a small opening of 150 feet from Portland to the south end of the proposed breakwater?—I should think not.

In war could a fleet of men-of-war and steamers keep their station off Portland as the bays of Weymouth and Portland now are, or would a breakwater in the entrance ensure their effecting that service in all winds and weathers?—They could not, supposing the wind at south-east; but if there was a breakwater, they would be able to get under weigh, and proceed at any time, as sailing vessels, with the wind at south-east, sheltered by the breakwater, would be enabled to get under weigh, let the weather be what it will; and by making a board to the north, would be able to round the breakwater, and proceed round Portland, with a flowing sheet.

Inside or outside the Shambles?—Inside with ebb, and I think they would be able to go to eastward with flood.

Night and day?—Yes; if they could see the land or lights.

Would a passage of 150 feet at south end of intended breakwater bring in any sea?—With wind at south-east, a great deal of sea.

(*Captain Fisher.*) Your answers have all been given with the understanding that it was in such weather that a ship could turn in?—They were.

Would not such an inner opening as referred to before enable vessels bound to the westward to leave this harbour in strong north-east winds, and make their passage round Portland and down Channel, when they could not work out of north-east entrance?—They would be able to run through such an opening with wind at north-east, but they would not be able to get their anchors; they must either cut or slip.

Could ships in strong westerly gales fetch the harbour from the east end of the Shambles?—Yes; in any tide.

Would it be necessary, in your opinion, to have a floating light placed on some part of the Shambles for the better direction of ships seeking this harbour in thick weather and by night?—I do not think it necessary.

What mark have you for clearing the east end of Shambles by night?—I should run to the eastward with the Upper Portland Light open to westward of the Lower Light, until I got the north part of Portland to bear north-north-west, or the lights to bear west-north-west. I should there haul in.

With the light bearing west-north-west and not knowing your exact distance, would it be safe, under all circumstances, to haul dead in to the northward?—Not in thick and dark weather, but I should make sure of my eastward by the distance run.

Under such circumstances do you consider a floating light on the Shambles would not be a great additional security and direction for large ships?—No, I do not.

(*Sir Henry Pelly.*) You understand that there would be a light on the breakwater?—Of course.

(*Captain Fisher.*) At what distance would the breakwater light be from the east of the Shambles?—About seven or eight miles, and Portland Light about the same.

(*Sir William Symonds.*) Do you consider that a distance of two miles from the north-east end of the proposed breakwater, to the west of the Bay, would be sufficient for men of war and all kinds of merchant-men to work out and round it with the wind off the land?—Yes; but two-and-a-half miles would be better, as it would rest on the wreck of the "Abergavenny," and the Bay will then be left clear of all wreck and danger.

Suppose wind from east-south-east to east-and-by-north, and a heavy laden merchant-vessel, many of which are ill-manned and unmanageable, fetches out of the inner or middle proposed entrances to breakwater, with an ebb tide, would she find embarrassment from the Race besides the coast of Portland; and would it not be very important to go out to north-east of the breakwater in order to fetch to eastward of Race, if they had not confidence or knowledge of the passage near the Bill?—In the first place, such a heavy vessel could not clear Portland, even with a weather tide; but if she went to the northward of breakwater, she could clear the land well.

Would not such openings in the breakwater subject vessels within it to wind and sea in heavy gales, and therefore to insecurity?—I should think so.

(*Chairman.*) Supposing a passage 600 feet wide?—Certainly; I think so, with such an opening.

(*Mr. Walker.*) How do you water the boilers of your steamers?—We use salt water.

Is there plenty of water on Portland?—From my own knowledge I cannot say, but I have heard from engineers there is a great deal. At Mill Cove, on the north of Weymouth, there is a plentiful supply.

You have stated there is about six inches of sand over clay in the Roads?—Yes; about that.

Does this increase or decrease?—I should say not.

Is it your opinion that if Portland Roads were closed in by a breakwater, that there would be any tendency to silt up?—I should say not, as there is at present little or no tide.

But is there not considerable silting up in Weymouth Harbour?—Not at all; the back-water keeps it clear.

Has it not been dredged out occasionally, to maintain the present depth?—It has, since the last Commission was here, and two-and-a-half feet gained.

Was that an accumulation from silt, or solid?—It was solid clay, and that depth was given and not recovered.

Has not that silted up partially since?—No, it has not.

Has the back-water silted up?—No; it scours out.

Mr. *R. White.*

29th May, 1844.

You named that you know cases of sudden shifts of wind from south-west to east, when ships have remained several hours after a change of wind; could they have got out had they chosen to do so?—Yes; I should think so.

To what winds do you consider the Roads at present exposed?—From east to south.

(*Chairman.*) How long is it since the dredging took place?—About three years.

And you have a dredging vessel?—Yes, a steam dredge.

Have not some embankments been made within a few years to keep out the water?—Not to keep out the water, but to make land for building.

You mean that buildings now stand where water formerly lay?—Part of the back-water has been enclosed to make building land; I should say about 150 acres.

Was it a space over which the tide flowed?—Yes.

Who are the proprietors?—There are several.

Do you know if the authorities were consulted in this?—The town council sold it for building.

Do you know if any reference was made to the Admiralty before it was done?—Not to my knowledge.

Have you any property there yourself?—None.

(*Sir Howard Douglas.*) Has this improved the harbour?—I do not consider that it had any effect either way.

(*Chairman.*) Were you here when the "Abergavenny" was lost?—Yes.

Was she coming in for Portland Roads when she struck?—Yes. It was in the evening, about dark.

Were other ships with her?—Yes, three others had gained the Roads.

Had she a pilot on board?—She had a fisherman, but not a pilot. I think that had there been a breakwater she might have been saved, as they would have run in during the early part of the day.

Would this wreck be in the way if a breakwater were made here?—Only in the way of an anchor. There is 9½ fathom over her. A buoy would be in the way.

Have you ever heard of a prospect for cutting through the Chesil Bank?—Never.

(*Captain Washington.*) Do you think if a cut were made, as has been proposed, through the Chesil Bank, that it could be kept clear of shingle on the west?—Never. I think the first moderate gale would fill it up.

Do you understand that the water upon the east is higher than on the west side of the beach by about 18 inches on ebb, and the reverse on the flood?—I have heard it was higher on the west both on flood and ebb.

Do you think if an opening were made there that the strength of tide would keep it clear?—No.

Where do the wrecks in the West Bay generally take place?—About Wyke.

Suppose a passage could be kept open through the Chesil Bank a quarter of a mile wide, might it not save vessels from going on the beach?—I think at such a time that there would be so much sea that it could not be attempted; they would not see it.

By removing the obstacle which causes the sea, viz., the bank, would not a great deal of the heavy sea be avoided?—I should think not.

(*Sir Henry Pelly.*) Would not such an opening injure the Roads?—It would probably destroy them and Weymouth also; town and Roads both.

(*Lieut.-Colonel Colquhoun.*) What is the motion of the shingle on Chesil Beach?—It heaves up, and does not travel either east or west; west and south-west gales heave it up.

What is the nature of the shingle?—It is largest near Portland, and gradually decreases in size as it goes westward, and opposite Bridport it is reduced to sand. Portland stops the shingle completely; it does not go beyond the village of Chesil. There is no shingle in the anchorage.

[*The Witness withdrew.*]

Mr. *Edward Allen.*

Mr. *Edward Allen,* examined.

(*Chairman.*) Where do you reside?—At Portland.

What is your occupation?—I am a part ship-owner.

In what trade?—In the Irish Channel and Straits.

Have you been much accustomed to Portland?—Until about 26 years of age, and then to the Irish trade. I was a branch pilot for this Port when a young man.

Should you have any difficulty in bringing a large ship into Portland Roads in night time?—None.

Would you bring her in between the Shambles or round to the eastward of them?—It would depend on the state of wind and tide.

Do the trade of the Channel in south-west gales take shelter here much?—Yes, from 50 to 100 at a time.

Have you ever seen ships riding in Portland Roads with a heavy gale from the eastward?—Yes.

Have you ever known them drive ashore with the wind at eastward?—Yes, several instances.

Were any lost?—They have been obliged to discharge their cargo to get them off.

Do you think if there were a breakwater here it would be much resorted to as a harbour of refuge?—I think many ships would come under a breakwater here when they

could not gain Portsmouth, instead of bearing up for Plymouth. Dartmouth is not a place fit for a heavy ship. Mr. *Edward Allen.*

29th May, 1844.

Do vessels coming in to Portland Roads get heavy gusts off the land from south-west?—They do, close in.

How far should you keep off to avoid it?—About a quarter of a mile.

Have you much considered a breakwater here?—I have considered long that a breakwater here would be a very desirable thing for shipping passing both up and down Channel.

Looking at the place of a proposed breakwater, would it be desirable to have an opening in it, and, if so, would you have it in the middle or at the south or inner end?—I would have no opening at all.

State your objection to an opening in the middle?—In the first place, the tide would set so much round the opening, there would be much difficulty in vessels working out in strong easterly winds; and next, an opening would let in such a sea that vessels could not lie with such safety as they would were there none.

Do you think if the opening were only 600 feet that this would be the case?—Yes, I do; it would be more difficult for heavy ships getting their anchors lying under the breakwater.

You speak of ships working out, but the opening is not made with that intention, as, in easterly winds, there is the outer end of the breakwater to get round?—I consider that if there were no middle opening the water would be so smooth that a large ship might get up her anchor and work out with the wind from the east, round the east end of the breakwater, and and thence clear the east end of the Shambles.

Now supposing an inner opening only 200 feet from the two-fathom edge, what are your objections?—It would expose all vessels lying in six-fathom water to a south-east to south-south-east wind.

There is a large quantity of stone lying on the Crown property in Portland, have the inhabitants any privilege to consider that as refuse stone, and their property?—The refuse that lies in the Queen's ground is her property, and neither the islanders nor other people have any claim to it.

(*Sir Howard Douglas.*) Do you consider that if such a harbour as proposed were constructed, that it would be much resorted to by the trade for shelter in peace and protection in war?—Both for ships bound up and down Channel, as, if the wind were from the eastward, they could get under weigh and go to sea, whereas they could not do so now.

You have said that vessels in strong easterly gales, if a breakwater existed, would resort to this in preference to Plymouth; would they prefer it to West Bay?—Certainly.

Why?—Because, should the wind fly to westward, there would be difficulty in getting out of the West Bay.

(*Admiral Dundas.*) In war time, would a breakwater enable men-of-war and steamers to keep their stations off here in all winds and weathers, which, under present circumstances, they cannot do?—Yes, it would.

There is a good deal of trade here in stone and fishing, do not you think it would add to the commerce of that trade to have a passage at the south end of the breakwater, between it and the shore?—No; I consider it would be a great inconvenience.

Do you know much of Beachy Head?—Yes, for many years.

Which side of Beachy Head would you construct a harbour to protect merchant-vessels, and enable men-of-war and steamers to keep that station in war time?—On the east.

Do you know the nature of the holding-ground in the East Bay?—Good clay bottom in Bourne Roads.

Have you ever anchored there?—I have, but have not sounded.

Is there any danger in running in there at night between the Royal Sovereign and the Holywell Bank in a large ship?—None, if there were directing lights.

Were you ever in Seaford Roads; what is the holding-grounds?—Good.

Suppose a breakwater, such at Plymouth, formed in Seaford Bay, would you, with strong westerly, bound down Channel, seek shelter under such a breakwater, or would yo run to the eastward of the Head and anchor in Eastbourne Road?—I should prefer the breakwater.

But supposing there were breakwaters in both Bays?—I should take Bourne Roads.

Do you apprehend any danger in running into Seaford Bay with a breakwater?—At night I might not get under the breakwater cleverly, my canvass not being sufficient; but if running for Bourne Roads, and I could not make my object in getting in, I should have the Downs under my lee to run for.

(*Sir Henry Pelly.*) Now suppose an easterly wind, which would you prefer?—I should then prefer the West Bay.

(*Admiral Dundas.*) In the event of war it would be necessary to have a harbour between Beachy Head and the North Foreland, where would you construct a harbour accessible at all times of tide and in all weathers for the benefit of the trade and for men-of-war?—I should say Dungeness.

Why do you prefer Dungeness to Dover?—In consequence of the cross tides at Dungeness.

What is the nature of the holding-ground in Dover Bay?—Very good, as good as under the Ness.

Suppose Dover Bay, encircled by a breakwater of two or three miles in extent, would the tides affect ships as much then as you apprehend they would now?—No, of course not.

(*Sir Henry Pelly.*) Why do you give the preference to Dungeness over the Downs for a harbour?—Dungeness affords a better outlet for the westward.

Mr. *Edward Allen.*

29th May, 1844.

(*Captain Fisher.*) How long have you been a pilot for this port, and do you consider yourself to have a perfect knowledge of it?—For 12 years for this port; and I consider my knowledge of it good.

As regards the passage in the south-west end of the proposed breakwater, would or would not such an opening in your opinion enable vessels bound to the westward, with the wind strong from the north-east, to leave the harbour with greater facility and make their reach round the island of Portland than if there were but one entrance to north-east?—I should say, yes.

Would they not be able to sail through that passage with the wind at north-east in such weather when vessels could not work from the anchorage round the north end?—If blowing so strong that she could not beat round the north; and it would of course be easier to go out of a south opening.

Ships running for this harbour in strong gales from the west, would they fetch the north end from east end of Shambles?—They would with ebb, but not with flood tide.

Would it be necessary or desirable, in your opinion, to have a floating light placed on some part of the Shambles for the better direction of ships seeking the harbour on dark nights and thick weather?—I should say it would be desirable, but difficult to keep it there.

Have you any night-mark for telling you when you are to the eastward of the Shambles?—Not at night.

(*Sir Henry Pelly.*) Would not a light on the breakwater answer the purpose?—Certainly it would.

What would be the distance of a light on breakwater from the outer end of the Shambles?—about four miles and a quarter.

(*Sir William Symonds.*) What is the mark for anchoring in Dover Bay?—I know of no particular mark.

Do you know how far the good ground extends off Dover?—I do not.

Do you consider it equal in extent to good ground at Dungeness?—I do not.

Is not the wind truer when there is low land like that of Dungeness than in the neighbourhood of high land?—Yes.

You say you are an old coaster, would you run for a port inside the Shoals, called the Royal Sovereign, the Horse of Willingdon, the Boulder Bank, and others, in thick weather, or dark nights, knowing from every chart of the Channel that there are foul spots in all parts of the Bay between Dungeness and Beachy Head, excepting Bourne Roads?—I would not.

[*The Witness withdrew.*]

Captain *C. A. Manning.*

Captain C. *A. Manning,* Vice-Lieutenanant of Portland, a Magistrate, and Deputy-Lieutenant of the County, examined.

(*Chairman.*) How long have you resided here?—For 27 years.

Does your acquaintance with Portland give you frequent opportunities of becoming acquainted with the anchorage?—It does.

What is the greatest number of vessels you have seen at one time in the Roads?—I think, 110 at one time.

Do you know any instance of ships being caught in this anchorage in an easterly gale?—I have.

And do you know any case of vessels being driven ashore for want of a protecting breakwater?—Yes, several, particularly in last February twelvemonth. In one case, a brig, the "Astrea," bound to the Mediterranean with Government stores; she had five anchors ahead, and was driven ashore. There were five other wrecks also.

How many at different times ashore?—Nearly 30 in the East Bay.

Is Portland much frequented by vessels in south-west or westerly winds?—Yes, frequently 80 or 90; from 30 to 40 being about a general number.

Have you been much used to the sea?—In yacht and boat-sailing a good deal.

Has it come under your observation that the stone-vessels throw their ballast over?—Yes; and I was particularly requested to bring it to the notice of the Commission.

Is it an injury to the roadstead of Portland?—Not the main roadstead; but within about a quarter of a mile from shore the approach is much injured.

We have been told that vessels come very generally without ballast?—Some, the billy-boys, do so; but all that come with ballast throw it over.

Is there any person, harbour-master, or other, who has a jurisdiction over this?—I do not think that the harbour-master of Weymouth has power over Portland.

But you, as a magistrate, have been applied to to represent the matter to the Commission?—I have.

Do you know the extent of the Crown property in Portland?—The absolute property is 282 acres 1 rood; but the power of the Crown gives a complete control over the waste, being a Royal manor.

There is an immense quantity of the cap and roche stone on the waste and other parts; have the people on the island any right to this waste stone?—None whatever; where on Crown property, it belongs to the Crown.

Is the stone we see about of a hard quality?—Yes, particularly under water.

This stone is not much in request?—No, on account of not being good for ornamental purposes, there being so much shell in it.

Captain *C. A. Manning.*

29th May, 1844.

Is there a plentiful supply of water on the island?—Plenty; and of good quality.

Does any lie within the proposed breakwater?—Yes.

(*Mr. Walker.*) Is it spring-water?—It is.

Whence do you suppose it derived, from rain collected on the island?—I should say from other sources; but do not feel prepared to go into the subject.

[*The Witness withdrew.*]

Mr. *Thomas Hitt Harvey*, examined.

Mr. *T. Hitt Harvey.*

(*Chairman.*) Are you residing at Weymouth?—Yes.

In what capacity?—As land-surveyor and clerk to the Weymouth Union.

Have you given much attention to the subject of breakwaters?—Constantly from the year 1812, when I assisted my late father in all his plans.

Will you have the goodness briefly to state your plan of a breakwater?—My views for a breakwater for Portland is that it should start from the Nose, or north end of the island, 60 chains south-east of the Castle, extending into the sea about 2½ statute miles, in a north-east direction, terminating on the wreck of the "Abergavenny."

How do you propose building it?—By forming two lines, one for the outer base, the other for the inner, and filling in between.

What stone do you purpose using?—That of the place.

What do you suppose the expense would be?—600,000*l.*, according to a detailed estimate.

(*Mr. Walker.*) In what time do you think it might be completed?—In six or seven years.

Do you, in your estimate, include anything to be paid for the lordship of the stone?—No.

Do you purpose using the cap and roche stone only?—The cap stone for the breakwater up to low-water mark, and the roche from low water upwards.

Do you consider it necessary to have that extent of breakwater, or is it only for the purpose of reaching the wreck of the "Abergavenny"?—I consider it necessary to reach the "Abergavenny" for two reasons, first, that the tide is scarcely felt at that spot; and, secondly, as a protection to Weymouth Harbour and esplanade in south-east gales.

Suppose a breakwater to give entire protection to Portland Road only, how far would you carry it out?—I do not consider it should be shorter than I before stated.

In constructing a breakwater, do you consider it would be desirable to have an opening 600 feet wide, not for working out, but for going out freely?—I do not, as it would interfere with the safety of the roadstead.

How?—By creating a tide and a deposit; also as being dangerous with wind at south-east, to vessels entering, to strangers especially.

What is the rate of tide within the Roads?—Very trifling, 1½ or 2 miles.

How will the opening create a tide?—As the back-water from the East and West Fleet is drawn off every tide, it would make its exit by the opening as being the nearest point rather than by going round the north-east end.

(*Admiral Dundas.*) If in the intended breakwater a second entrance were determined on, where would you advise it to be placed as most convenient for all vessels, particularly for the stone and fishing trade?—The nearer the shore the safer for small vessels.

Would it not be worth trying to leave a passage open to the south at first, and if found detrimental to the harbour, it might be easily filled up?—I do not think it would be advisable to have an opening, but there would be no harm in trying it, as you propose.

[*The Witness withdrew.*]

Mr. *John Jerrard*, examined.

Mr. *John Jerrard.*

(*Chairman.*) Are you harbour-master?—Yes.

Have you any control over the anchorage in Portland?—None whatever.

Has the water in Weymouth Harbour diminished?—Never in my recollection.

What quantity of land has been taken in from the back-water?—I cannot say; perhaps 30 acres or more.

By whom are you appointed?—First, by the corporation, and latterly by the town council.

(*Mr. Walker.*) What depth of water at high-water spring-tides was there formerly over the lands now enclosed?—About 3 or 4 feet on the outer part, near the lake.

Was there any question at the time as to this enclosure lessening the back-water, and thereby injuring the harbour?—No.

Do you not consider that the capability of your harbour depends on the back-water?—No.

Then on what does it depend?—We have no shifting sands; the tide keeps it clear; the ground is hard blue clay.

Suppose an embankment formed above, and all the back-water removed, would it not improve the harbour?—Supposing that case, it might.

(*Admiral Dundas.*) Has the harbour improved since the enclosure of the 30 acres you mention?—Yes.

Mr. *John Jerrard.*
29th May 1844.

Is it from such enclosure or from dredging that the harbour has improved?—From the dredging.

Has the enclosure been detrimental?—Not at all.

Have you turned your attention to the subject of a breakwater in Portland Roads? I have.

State where you would put a second entrance, the first being round the east end, to give facility to the trade, especially stone and fishing vessels?—I consider that an opening would be very necessary; and it should be between Portland and the breakwater.

(*Chairman.*) Is it considered that the corporation have a right to enclose any portion of the backwater?—We have always considered so.

(*Captain Fisher.*) Are you a seaman by profession?—Yes; but have not been at sea for 30 years.

Have you a general knowledge of this port and its entrances?—I have.

Do you consider that ships seeking shelter in a harbour constructed in Portland Roads—seeking shelter in strong westerly gales—would in general come in between the Shambles and Portland?—Yes, they would.

Do you consider that it would be necessary or desirable to have a floating light on some part of the Shambles, for the better direction of ships seeking shelter in this proposed harbour at night or in thick weather?—It would be very desirable as a guide for ships coming into the harbour.

(*Mr. Walker.*) Was not the ground that was reclaimed sold by the corporation for building?—It was.

Were not some of the corporation purchasers of this land?—Yes; some two or three.

[*The Witness withdrew.*]

Capt. *C. F. Payne,* R. N.

Captain *Charles Frederick Payne,* R.N., examined.

(*Chairman.*) How long have you been resident here?—All my life, except when at sea.

Have you ever been professionally employed here?—Only two days in a sloop-of-war.

Has your consideration been turned towards a breakwater in Portland Roads?—Not much.

Do you know of any vessels having driven out of Portland Roads in south-west gales?—Yes, several; and in the gale of 1824, from S.S.E. to south, several vessels were driven on the north shore at Osmington, and wrecked.

Supposing a breakwater to be carried out a length of two miles, and vessels parted in a heavy gale, would there be any risk of their foundering on the breakwater?—Yes, very great risk.

(*Sir Howard Douglas.*) You would consider it advantageous to construct a harbour of refuge here?—Certainly, and that it would be greatly resorted to.

Do you think it essential that there should be a southern opening to the breakwater?—Yes, I do; in case of the wind chopping round to the north or north-east.

(*Sir William Symonds.*) Is your experience derived from actual experience in using Portland Roads, or is it merely a matter of opinion?—It is a matter of personal observation.

How long is it since you have been in actual service on the coasts of the Channel?—Thirty years; but during that time I have sailed about in cutters and boats in Portland Bay.

Have you been out in these boats night and day, winter and summer?—No; only in the day-time, occasionally in winter and summer.

[*The Witness withdrew.*]

HARWICH.

Thursday, June 6th, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *Isaac Saxby.*
6th June, 1844.

Mr. *Isaac Saxby,* examined.

(*Chairman.*) What vessel do you command?—The revenue cruizer, "Scout."

How long have you been on this station?—Between 16 and 17 years.

You have been afloat all the time?—I have.

What change has taken place in the channels within your remembrance?—The point of Landguard Beach has grown very much to the westward, and choked up the old channel.

How do you account for that?—It is in consequence of the cliff at Blackman's Head being washed away.

In what manner do you account for the washing away the cliff having had that effect?—I think in consequence of the cliff wearing away an effect has been produced on the current.

How has that affected the point on the opposite side?—It has thrown the water on the other side; the force of the water strikes on the other side, and causes the point to come out; if the land was to wash away half a mile, the other would follow it.

Mr. *Isaac Saxby.*

6th June, 1844.

In what degree is the land at Blackman's Head washed away?—I should think pretty well a quarter of a mile.

Did the cement stone, which has been said to be removed, form any sort of barrier round the foot of the cliff?—Yes, in those days it did; when I first came here the cliff did not wash away nearly so fast as it has done latterly; I think the removal of that has been one cause.

To what height did that stone stand so as to form a barrier?—In some places three or four feet high on Blackman's Head.

Now it has been entirely removed?—Yes, it is taken away altogether.

Is the removal still going on?—Yes.

Are the tides more feeble than they were?—Yes, thay run at a less rate; thousands of tons have been taken away opposite my house, which causes the sea to come in and wash the land there. I have repeatedly stated what would be the case, that Harwich would wash down if they kept undermining the land.

What alterations have taken place in the channels?—When I first came to Harwich, about 16 years ago, the best entrance into Harwich was with the lights a little open to the eastward; but now you must have them a long way open to the westward.

Do you mean one light opening of the other?—Yes; the high light opening to the eastward in former years, now its breadth must open to the westward.

You mean to say that the water did not wash the foot of the cliffs so much before the stone was removed?—No, it did not; the stones acted as a breakwater to it.

Is there any other part of the harbour or neighbourhood from whence stone is removed?—All the way round in the bay.

Did you ever hear of any mischief being attributed to its being removed from other parts?—Yes; the land is falling away at the back of Dover-court, close at the back of my house; there have been fields washed away in the Bay to the westward of Blackman's Head.

Whose property was that?—I do not know.

It was not the property of the Government?—Not that I know. I think some of it belonged to Mr. Pattrick; he has had a whole field washed away within my remembrance.

Has the wasting away of the cliff, on that side, been as great as it is here?—I think it is quite as great.

Does your experience enable you to suggest any remedy for the evil you have represented?—If there was a breakwater off Blackman's Head, that would force the water over to the eastward, and drive the point of the beach away again.

You mean that it would drive Landguard Point away?—Yes.

What advantage do you expect from driving Landguard Point away?—I think there would be more water in the harbour.

Why?—The beach will sometimes wash in a little.

Do you think that Landguard Point, stretching out as it now does, forms a protection to the harbour from the sea?—Yes; it forms a very good protection in that bay when the wind is southerly.

You would take away that point?—I would diminish it. I think you could find more water there. On this side it is rocks, and on the other side it is shingles, which is borrowed from the sea; it is much more easily driven away.

Have you ever heard the pilots complain of inconvenience from the state of the harbour?—They have complained about the Point.

They have complained in conversation?—Yes.

They have complained of it as tending to narrow the channel?—Yes, it is much narrower than it was in former years; there is the best water close along the beach.

What is the shoal which is most inconvenient in entering the harbour?—The Altar Bank has been most in the way.

Is that diminishing in size?—Yes, in former years there was not above five feet water over it.

From what cause do you suppose it has diminished?—They have taken a great quantity of stone off it.

Did you ever hear of any complaint of the taking of stone from any other place than the Blackman's Head?—I have heard Mr. Pattrick complain very much of the taking away of the stone from the back of his fields; he had made a barrier to keep the sea off, but now it is taken away; the moment the cliff falls down, there are people constantly employed in digging out the cement-stone; thousands of tons are dug up.

Do you suppose it to be the greater spread of water from the taking away the stone from the Ordnance premises which causes this inconvenience?—Yes.

Did not the water reach above the barrier you speak of formerly?—At high water it did.

At high water the foot of the cliff was washed formerly?—Yes.

Was not the cliff carried away before they began to carry away the stone?—It was a little, but not so much.

There was a decay of the cliff, but not to the same extent?—Yes.

The whole object you had in view in running out a breakwater, is to act on the beach in Landguard Point?—Yes.

Supposing the whole frontage were enclosed down to low-water mark, would that be better or not than the running out a breakwater?—No, I should think that the breakwater would be best.

Mr. *Isaac Saxby.*

6th June, 1844.

Would not that measure restore the loss of the stone which had been taken away?—It must be thrown a long way out, for there has been a great deal taken away.

Would not that give a fairer line to enter than throwing it over in the other direction?—The running a pier out, it would send it over with greater force.

Is there much sea comes into the harbour at Harwich with the wind blowing in?—Not so much as might be expected; the shoals break it outside after you have just run clear of the Altar.

It is no part of your idea that the breakwater is to give a protection to the harbour, but merely for the run of the tide?—It will break off the sea in a S.S.W. wind.

Your idea is merely to have a breakwater for the effect on the Point?—And for the protection of the harbour also.

To what degree has it been an inconvenience to the anchorage when the sea sets in?—A ship may ride here at any time; the worst winds that blow are the winds from the north-west, and W.N.W.; they blow right down Manningtree River.

When you say the west wind or the W.N.W., you are going from the sea entrances up to the anchorage inside?—Yes.

Where do they feel the north-west wind most?—In Manningtree River, the Stour.

There are three old men-of-war sunk off the Ship-yard, have you ever heard any complaint on the part of pilots or the people of the place of those ships being there?—I have heard them say that it would be much better if there was a breakwater to lay the vessels alongside, and to protect the vessels in a wind.

Have you heard any complaint of those vessels lying there as affecting the tide?—No, there have been various opinions about it; one opinion has been that that has driven the shingle round towards the Dock-yard in gales of wind from the north-west; sometimes it will drive the beach considerably away.

Did not the tide run stronger there before than it does now?—I do not know, they have been laid there all the time I have been in Harwich.

What is the greatest number of ships you have ever known here?—I think I have seen 500 or 600 vessels of different descriptions here at one time.

Coming in here for refuge?—Yes.

What is the largest ship you have ever seen here?—I have seen ships of 600 or 700 tons.

Have you ever seen any men-of-war here?—No, no larger than sloops-of-war; I have seen them here.

Have the pilots any difficulty in bringing in the vessels at night?—No, not at all, when the weather is clear.

What is your apprehension of the consequences, if the breakwater should not be run out in the manner you describe?—I think the Point at Landguard will still extend away to the westward and choke the entrance of the harbour up so much that there will not be water for any large vessel to come in at low water.

A great many vessels, when they do not come in, anchor in the Rolling and Pitching ground outside?—Yes, that is according to how the wind is.

Where are they?—The Rolling ground is just outside of Landguard Beach, to the southward; the Pitching ground is to the eastward of Landguard Point.

(*Sir Howard Douglas.*) Is the bank, called the Guard or Harwich Shelf increasing?—No, I do not think it is increasing; it is all a dead flat; there is no navigation upon it.

Have you reason to believe that that is extending outwards?—I think it has accumulated to the eastward.

If you know that it has from any mark or sounding, have the goodness to state it?—No; I only go by the marks over yonder; we have to go further eastward to the West Channel to enter.

Is the Glutton Shoal increasing?—No, I do not think it is; in former days there used to be less water on it than there is now.

Is it a deposit?—It is clay, and a few stones intermixed along with it; it might be removed.

Is that deposited by the current?—I think it is by the tide setting round.

You know what is meant by deposit?—Yes, that it is collected there itself by the set of the tide.

Do you know the Altar Flat?—Yes, that was cement, stone, and clay.

What is the state of it now?—It is diminishing fast, in consequence of its being taken away.

Is that from a deposit?—No, that has been there ever since I have known Harwich.

What do you consider the elongation of Languard Point to be occasioned by?—The tide setting round to the eastward; it causes an eddy tide.

The flood-tide sets from the eastward?—Yes.

It is clear to you that the eddy of those two currents occasions the elongation of the Point?—Yes.

You think that a breakwater from Beacon Cliff would have the effect of changing the current?—Yes.

Do you think that the action of the current, which would be caused by the construction of the breakwater, would be produced on the ebb-tide or the flood-tide?—By the ebb-tide.

Mr. *Isaac Saxby.*
6th June, 1844.

Will not the ebb-tide operating on this breakwater have passed the Point during that action of the ebb; how do you think it will operate?—In consequence of the breakwater we have here, it will cause a very strong ebb-tide, and force it away.

Would it be more likely to produce that effect if the breakwater were placed higher up?—Anywhere along here from Blackman's Head towards the Lighthouse would answer the purpose.

On consideration, do you not think, so far as the effect is produced by deflecting the current from the west side, it would be likely to be more efficacious if the breakwater were higher up?—Within Blackman's Head and the Low Lighthouse would answer the end.

(*Chairman.*) What would be the effect of this breakwater from the Beacon Cliff on the channel of the river during flood-tide; would it not increase the eddy?—No, I think the tide would set right in.

Is the western channel to the harbour of Harwich shallowing and narrowing, or deepening and extending?—I think there is as much water there as there ever was; there is a channel called the western channel, but it is not a navigation for large ships; only very small vessels come through that channel, it works further to the eastward; but I think there is as much water on it as ever there was; the banks are washing out to the eastward and becoming narrower.

Is the bank to the southward of the Cliff Rock diminishing?—Yes, they are working it away; it is a dead flat along there.

Has everybody a right to take the cement-stone?—No, it belongs to certain merchants; they pay so much to collect and dig it up.

To whom do they pay for the privilege of collecting it?—I do not know.

What do you think would be the effect of reclaiming as much as possible of the bank to the southward of the town, between the town and Blackman's Head?—We might have a good way there for embarking or disembarking troops at high water; ships might lie along side for taking in troops, but they must go off again.

Would not the effect of reclaiming a large quantity of this bank, the Harwich Shelf, be the throwing the current more to the eastward side of the river, and consequently improve not only the main channel but the west channel also?—Yes.

(*Adm. Dundas.*) Have you ever known a ship drag her anchor in Harwich Harbour?—Many.

Is the holding-ground bad?—No, but they do not give them cable enough; it is through neglect.

Is the holding-ground good or bad?—Good.

Would all the alterations you have proposed make Harwich such a harbour that vessels could enter and leave the port at all times of tide, wind, and weather; night and day?—At any time; ships drawing not more than 18 feet water could come in at any time of the tide if they could sail in, and were acquainted with the deep-water channel, which is but narrow.

What sort of holding-grounds is there at Hollesley Bay?—Very good.

Did you ever know a ship drag her anchor there?—No.

What is the worst wind there?—I think the wind at east or E.N.E.; with the wind southerly, the Whiting Shoal protects it.

What distance is it from the end of the Whiting to the shore?—About a mile.

What sort of ground is there upon the north of the shoal?—Beach, and very steep beach.

If a ship goes well up in the bay, she is protected by the shoal?—Yes.

You consider Hollesley Bay very good anchorage?—Yes; I have rode there many times, and I have thought myself safe.

In what depth of water?—Five fathoms water.

With what bottom?—Clay and sand.

(*Sir Howard Douglas.*) Do they take away the stone at Blackman's Head immediately from under the cliff, or are they limited to a certain distance from the cliff?—Close under the cliff.

Do you mean on the Ordnance land?—Yes, I have seen it taken away from the Ordnance land in boats.

Are they not limited to 50 yards off?—I have seen the boats lying close against the cliff, but that is a business I have never troubled my head with.

They might have the vessels close alongside the cliff, but not take the stone from thence?—I have seen them loading the boats there when I have been out in the galley close under the shore.

(*Capt. Fisher.*) Where, in your opinion, would be the best place to establish an asylum harbour on this coast, anywhere between Orfordness and the North Foreland, accessible at all times of the tide for men-of-war, armed steamers, and merchant ships of the largest class?—I should say Harwich.

Does Harwich afford the means of a supply of water, fuel, and other necessaries which may be required for such a squadron?—There is plenty of fresh water at Shotley and Erwarton, thousands of tons are running away daily, they might get plenty of fuel here; and there might be plenty of provisions of all kinds procured from the country round at any time.

Have you observed, or do you know that Harwich is much frequented by ships approaching to or leaving the Thames in bad weather, or meeting with contrary winds?—It is the only place of refuge for them at present.

Mr. *Isaac Saxby.*
——
6th June, 1844.

Can ships-of-war and merchant-ships of the description mentioned at present approach Harwich through all the channels, through Hollesley Bay at all times of the tide?—Yes.

The general anchoring-ground you say in the harbour is very good?—Yes.

(*Sir Howard Douglas.*) Where is the quarter of a mile you describe as having been washed away?—To the westward of Blackman's Head.

Has any been washed away from the Head itself?—Yes, a great deal.

How much from Blackman's Head eastward?—I cannot rightly say.

One hundred yards?—Yes, there may have been.

So that the washing away you refer to is what has formed the bay to the westward of Blackman's Head?—Yes.

If only a hundred yards has been removed from the space to the eastward of Blackman's Head, do you not consider that that would be what would regulate the extension of Landguard Point, more than the washing away in the bay to the westward of the Point?—I am not quite sure of the extent which has been washed away from Blackman's Head, I have not been up there for years.

(*Capt. Washington.*) You stated that the Altar Bank is composed of clay and cement-stone?—Yes.

A part of that has been removed by dredging?—Yes.

Is Glutton Bank composed of the same materials?—I am sure I do not know.

Would there be any difficulty in case of a ship losing her anchor and cables in running into Harwich Harbour and saving her?—Not the least, a vessel may come in at 18 feet at low water.

Could not the largest ship of the North Sea fleet, 25 years ago, have come into Harwich Harbour?—I did not know Harwich Harbour then, it might at any time I have known it.

With what draught of water?—At low water, a vessel may come in now at 18 feet; and any sized ship belonging to the British Navy at high-water, with any gale of wind that blows, if they can sail in.

When you speak of any class of vessel, what draught of water do you refer to?—Twenty-five feet.

There would be no difficulty in it?—No, not with a fair wind.

What is the rise of the tide?—Twelve or thirteen feet.

What is the depth of water at low spring-tides?—Eighteen feet.

[*The Witness withdrew.*]

Captain
Frederick Bullock,
R. N.

Captain *Frederick Bullock,* R.N., examined.

(*Chairman.*) How long have you been on this station?—I think I have been backwards and forwards three or four years.

Are you aware of any injury done to the harbour of late years, and if so, to what do you attribute it?—Only from hearsay; I have not examined the harbour myself; that has been left to Captain Washington.

Looking at the chart before you, you see a breakwater marked, which do you think would have the best effect, a breakwater in that direction or enclosing the shore in front of the Ordnance premises, and so giving a direct line to the tide?—I think the enclosing of the shore.

Why?—Because by occupying the whole space you give effect to the tide; but here you do not; this (the breakwater) is too abrupt and too far out to have any effect.

Do you consider that the enclosure of the bank along the low-water mark would have the effect of restoring in a great degree the natural run of the current?—Yes; because it appears to be restoring the natural boundary of the current.

Do you know of your own knowledge of any injury done to the harbour by the removal of the cement-stone?—No, only from hearsay.

Does not the lengthening of Landguard Point tend to give a protection to the harbour?—The extension of Landguard Point would protect the harbour, but will only protect the entrance of the harbour.

From your experience and knowledge of the harbour, do you think it desirable to reduce the shingle at Landguard Point?—Yes, if it were possible, I think I would reduce it; but I do not think it is possible.

You do not think that by any operation of the tides you could effect that?—No, I do not, for the tide is now so strong in the narrow channel near the beach, and yet the beach appears to increase.

What do you suppose has occasioned the elongation of the Point?—The accumulated shingle from the eastward and the washing out of the excavation of the bay to the westward of the beach point.

You think that the shingle from the eastward in gales of wind from the east comes in here?—Yes, it appears so to me.

Are there any groynes along the shore to the eastward?—I believe at Felixstow there are a few, but not near the Fort.

Do you think that groynes run out here would have the effect of checking the growth of the beach of Landguard Point?—Certainly, it would arrest its progress for a time.

Captain *Frederick Bullock*, R.N.

6th June, 1844.

Groynes on Landguard Beach?—Yes, to the eastward of the beach point.

If by any process, by groins or other means, you can prevent the beach extending further, will not it be better to leave it as it is than to attempt to act upon it by altering the tides?—My opinion is, that without some very great and expensive undertaking you could not act upon that by anything on the opposite side; indeed, I doubt whether any breakwater on the west would bring the current to act upon the beach point; for the strong tide is on the east, which it would be neither easy nor advisable to turn aside. The velocity of the tide on the east side of the harbour entrance is nearly double that on the west; it appeared to be running nearly four knots yesterday.

You think that the breakwater would tend to prolong the tide, and that the other plan would tend to give it a fair direction?—Yes, by enclosing the low-water line.

You prefer the latitudinal line to the longitudinal one?—Yes, I do infinitely.

(*Sir Howard Douglas.*) You think that the great object should be by reclaiming the land opposite the Ordnance, to throw the current as much as possible to the eastern side of the river, and so to improve the Channel?—Yes, I think by that and other means the harbour would be improved.

You have said that a breakwater running out from Beacon Cliff would be too low or too far out to have any effect on Landguard Point?—Yes, that is my opinion.

Do you not think that, upon the principle of throwing the current as much as possible to the eastern side by the process of reclaiming, it might be advantageous to have a breakwater somewhat higher?—I should prefer it further in certainly; but my opinion is, that there is nothing which could be done to the tide on this, the west side, which would have any effect on the other side, as the force to be employed in this operation is the weaker.

At what point would you propose a breakwater to be placed?—Commencing at the inner part of the land at the north-eastern point of the Harwich shelf, and leading the tide out in a fair direction to the entrance of the harbour.

A breakwater springing obliquely from the north-eastern part of the shelf?—Yes, that is the only means to be recommended.

(*Adm. Dundas.*) With all the alterations that you ever heard proposed, could Harwich be made such a harbour that ships of any draught of water could enter and leave it at all times of tide, wind, and weather, night and day?—No, certainly not; because the Channel on the outside has only, I think, 15 or 16 feet in the leading channel between the buoys, therefore it is fruitless to deepen the harbour beyond that; I take the depths from the chart before me. I have not sounded the harbour or the entrance.

(*Sir H. Douglas.*) Have you of your own knowledge ascertained, and are you prepared to say what the consistency of those banks is?—I examined the material excavated the other day, the bank was composed of cement-stone and shingle, mixed with mud.

Do you think that any part of it is deposit from the current?—I think it not unlikely, but that there would be no difficulty in removing the deposit.

So far as it is the effect of deposit being removed it will come back again?—Yes, it would still be liable to return and must be attended to.

Will you describe the anchorage at Hollesley Bay?—I have not examined it.

(*Capt. Fisher.*) Do you think that Harwich could be made at any expense a harbour of refuge for ships of all sizes to take shelter in gales of wind?—No, not for ships of all sizes, for there would not be water.

Of what draught of water?—I cannot say precisely, but taking this chart for my guide, and supposing that the plan is correct, I would say that 15 feet is the utmost.

Are the Commissioners to understand that the knowledge you have had of Harwich is derived from hearsay and not from actual observation?—Some portion of it is from hearsay, and the view of this new chart of Harwich, and some from actual observation.

Be so good as to say what part of it is from actual observation?—That of removing the shoals in the interior, by which the harbour would be materially improved and a great national benefit bestowed.

You have no knowledge of Hollesley Bay?—No, it has not been recently examined, but it is in my orders to survey it.

(*Chairman.*) Do you know anything about the pitching-ground?—No.

Do you recommend the removal of the obstructions which are in the way of the western Channel?—Yes; indeed, I recommend the removal of all the shoals; I believe the whole of them can be removed at a moderate outlay.

(*Chairman.*) Would not that have the effect of reducing the depth of water in the deep-water channel by the extending of the tide over a greater width?—Theoretically it might, but I think only in a very small degree practically.

Have you ever measured the rate of the tide in Harwich harbour?—No, but I observed yesterday that it was running about four knots an hour.

How is the state of the tides now?—Past the springs.

[*The Witness withdrew.*]

Captain *George Deane.*

6th June, 1844.

Captain *George Deane,* examined.

(*Chairman.*) What is your situation?—I am a retired packet officer.

How long did you command a packet on this station?—Nearly 30 years; I was altogether on this station more than 30 years.

Are you a native of this town?—I am.

And holding property in it?—Yes.

You were never a pilot yourself?—We were our own pilots for Gottenburg and Cuxhaven, and the different northern ports.

For how many years have you had a knowledge of this harbour?—I can remember it for more than fifty years.

What is the largest ship you have ever seen in Harwich Harbour?—The largest ship with her armament aboard was a 50-gun ship, the "Brackel," an old Dutch 50-gun ship.

What was her draught of water?—I should expect about 20 feet.

She was a flat ship?—Yes.

How many ships have you known here of large size, men-of-war?—I cannot challenge my memory, but I have known frigates and many smaller ships-of-war.

There appear to be two channels in the harbour, a deep-water channel at Landguard Fort and a western channel, are you aware of any change in them?—The eastern channel has diminished in depth and width very much.

You are certain of that?—Yes, I am.

Are you sure of that from your soundings, and having ascertained it, or only from hearsay?—From my soundings thousands of times.

What is the difference between the depth now and what it was in former times?—I have not been at sea myself in active service for these ten years.

On what authority do you assert that there has been this change?—It was changed very much before I left off going to sea, and I went out in Her Majesty's steamship the "Blazer" with Major Beresford last year, and I found that where I could formerly sail in at low-water there is now beach at high-water.

You could sail in formerly—in what description of vessel?—Vessels drawing ten feet, but there had been vessels of a much heavier draught of water than that.

How do you account for the lengthening out of Landguard point?—I attribute it to the falling down and the washing away of the Beacon Cliff, commonly called Blackman's Head, the which has been caused and accelerated by the excavating for the cement-stone.

When did the excavation for the cement-stone commence?—I think about 20 years ago; but they always collected it from that shore before they began to excavate.

By the removing of the cement-stone from the shore, has a barrier been broken down which protected the foot of the cliff?—In my humble opinion they have taken away the only barrier that protected the foot of the cliff, and that also turned the current against the south-west point of the beach.

To what degree has the barrier been broken down?—Several hundred thousand tons have been taken away.

How much land has been taken off?—The land has fallen down and been lost in consequence of the taking away of the stone.

To what extent has land been lost?—The ground, within my recollection, must have lost twenty or thirty acres.

How deep has it gone from the front?—I should think 250 yards within my recollection, nay, more since I was a boy.

You mean to say that the sea flows up 250 yards further than it used to do?—Yes, and more too.

Do you know of any cement-stone having been taken from any other places?—Yes, from Felixstow; but I was not an eye-witness of that; and also from the West Rocks, out to the south-east, they are raising it there every day.

Did you ever hear of any complaint of the taking of cement-stone from any other property than the Ordnance property?—Yes; stone is taken by the lord of the manor of Dovercourt or his lessees.

What is his name?—Nathaniel Garland, Esq.: Dovercourt is to the westward of the Beacon Cliff.

Do you consider that the spread of the water diminishes the force of the tide?—Certainly.

And that from that the mischief principally arises?—Yes; yesterday I was walking round the cliff and I saw a man with a basket on his shoulder grubbing the stone out from the foot of the cliff and taking it to his boat; that was not on the Ordnance property, but at the foot of the Parson's glebe: the parson having only a life interest, cannot afford to go to law to protect his glebe, and it is depredated upon daily by the lessees of the lord of the manor.

What would you propose to do to remedy this evil?—I would give it as my humble opinion that the replacing the barrier which they have removed would turn the tide against the point of Landguard Beach and prevent its further accumulation.

What you would wish is to prevent its further accumulation, but not to diminish it?—I think it would also be desirable to diminish it, if possible; for you cannot come in with the Harwich Lights in one as you used to do.

You state what has been the effect of taking the cement-stone from the front of

Captain *George Deane.* — 6th June, 1844.

the Ordnance premises, but why should that have occasioned the elongation of Landguard Point?—Because the strength of the current which was turned formerly there is much diminished, the current at the ebb runs longer to the south-west, and does not exert itself against the beach point as before.

Is it not more likely that the point is extended from the beach, coming along to the north-east of the point seaward?—The point washes from the north-east, I believe, but it was formerly carried away by the ebb-tide in a great measure.

Do you suppose that the throwing groynes out will check it and prevent the mischief?—I have my doubts upon that subject, but I do not pretend to be an engineer; I think the tide ought to be turned against it; the tide runs longer out to the south-west; we could not row a boat in close to Beach End against the ebb formerly.

Which is the worst shoal in the harbour?—The Glutton Shoal I think is the worst, but vessels may anchor in great safety outside that.

Is not the Altar very much in the way?—It is.

Is that increasing or decreasing?—I think it is decreasing; they have raised or dredged stone from that.

What is the constitution of that?—It is cement-stone and platimore, or blue clay.

Do you think the old ships sunk off the ship-yard do any mischief?—None whatever, Harwich would be very awkwardly situated without them, we could not discharge a cargo of coals without them during north-west gales.

Do they effect any mischief by turning the current?—No, not in my opinion.

It has been strongly asserted by Captain Bridge, that the placing the ships there has done very considerable mischief?—I do not place any reliance upon the evidence of Captain Bridge, especially respecting the "Bacchus," who has stated what it is incongruous to suppose, viz. that so small a bulk as the "Bacchus," should cause any retrograde motion or eddy of the tide placed at that distance from the beach, and it is wholly impossible.

In what part of the town does your property lie?—In several parts; in Church-street, in King's-street, and in St. Austin's-lane.

Does it lie near the shore?—No, one property is about fifty yards from the shore.

This question was put to Captain Bridge by the Committee on Shipwrecks, "Is there any other point?" to which he replies, "There is one point. In the papers of Captain Washington, who was the naval surveyor on the eastern coast, he states the reason of the harbour of Harwich growing up where I have seen a 74-gun ship go out, and it is now six or seven feet above high-water mark; he imputes it to the taking away the cement-stone; now that is not the case, the ship-yard of Harwich is at a corner; 20 years ago the corporation had influence enough with the Government to get into their breakwater two old men-of-war, lying abreast of the town and another small brig: they laid that at the corner; before that the tide was so rapid you could not row a boat round it; but the tide in consequence went off into the middle of the harbour and joined the Ipswich water, and went with all its force against Landguard Fort: they had great difficulty to prevent the sea breaking into the Fort. If they were to take away that breakwater, my opinion is that the Channel would open of itself; the breakwater is of no earthly use but for the benefit of the ship-builder, for when it was not there the sand kept up so high it used to take them a great deal of money to dig away the shingle; since that has been there he has been at a great deal of trouble to underpin the wharf." Have the goodness to state any objection to which you feel that is open?—I totally disagree with it in every point, because so small an object placed at such a distance as that is from the Beach End could never occasion the retrogradation or eddy of the tide so as to occasion an accumulation at Landguard Point.

Are the ships placed there for the protection of the ship building-yard or for the general advantage of the harbour?—Two of the ships are placed there for the general advantage of the harbour—the "Ethalion" and the "Glatton."

How do they act for the advantage of the harbour?—By sheltering the landing-place from the W.N.W., winds; that is where the gales are most felt. The "Bacchus" has not been placed there many years, but there always were two ships there as long as any one can remember; there were two ships there when I was a little boy, where the "Ethalion" and the "Glatton" now lie.

What would you propose to do to remedy all this?—It seems to me that by carrying a pier out from the Beacon Cliff or from the lighthouse, you would turn the tide against the point of the beach where it used to run before.

(*Sir Howard Douglas.*) In your opinion, which is the best position?—I should rather say I would have it more to the northward, nearer to the small lighthouse. This Point (*Landguard Point*) runs out further than it did.

In what way do you suppose the tide will act on Landguard Point in consequence of the erection of the breakwater?—By preventing the ebb-tide running to the south-west.

How far would you propose the breakwater running out?—Six or seven hundred yards to the south-east.

Which do you suppose will have the best effect, enclosing the whole front of the Ordnance ground to Beacon Cliff to the extent of three or four feet below low-water mark, or to throw out a breakwater?—I should think a breakwater would answer every purpose; that enclosure would be a very expensive work.

Independently of the question of expense, which would be the best?—I have never considered such an enclosure, for I never could suppose it would be done.

Captain *George Deane.* 6th June, 1844.

Why?—Because it is not wanted; small vessels sail over that part at high water.

Would not the enclosure of this land give a fairer direction to the tide instead of an abrupt throwing off of the tide?—No; because I think that a breakwater is just what is wanted; there is 10 or 11 feet at high water over that shore, called the Guard.

The question is as to the effect upon the shoals?—I do not think that would answer the purpose so well as a breakwater.

(*Sir Howard Douglas.*) Your object is to throw the current over to the other side of the river as aremedy?—I want to turn the current to the south-east against that south-west point of Landguard Beach.

Do you mean 600 or 700 yards from high-water mark or from the beach?—From high-water mark.

Would it not be an advantage to the proprietors of property in the neighbourhood from which the cement-stone is obtained if the Ordnance were to cease to permit the stone on their property being taken?—I think it might be; but the Ordnance or their lessees excavate and take the stone from their own sea-face only; they did once manufacture it themselves.

Is there any proprietor of land whose working it would injure the harbour if the Ordnance ceased working it?—Not any one *half* so much as the Ordnance, for their land lies just at the entrance of the harbour, and the others more to the westward; but there is no proprietor who does work it; there is no one who has the right; the lord of the manor affects to have the right; I am of opinion he usurps the right which belongs to the Queen.

(*Lt.-Col. Alderson.*) If the Ordnance ceased working, is there any other person whose property lies near the harbour, whose working would affect it in the same way?—No.

(*Chairman.*) Whose property lies near where the stone is taken?—The principal part is the Parson's Glebe. Mr. Sansum has a *small* property of cliff face; Mr. Pattrick, Mr. Randfield, and Mr. Bagshaw, all small sea frontage.

Those are all to the westward?—Yes, all out of the harbour.

Does not the working there do a considerable mischief by narrowing the sort of isthmus that lies between the Stour and the sea?—Very much so indeed; that is going very fast.

Then if the Ordnance should be prevented working in front of their land, ought not others to be prevented working in the West Bay?—There cannot be a question of that; whenever there has been a trial about it, it has always been lost; by the lord of the manor it is an assumed *manorial* right only, in my opinion.*

Actions have been brought against the proprietors of manors?—Not in this place, but it has been tried in Sheppey and in Walton; it was tried a year ago, and the lord lost his cause.

(*Chairman.*) Has not a public representation been made to the Ordnance about the taking the stone from the front of their premises?—Yes; when I was mayor, a year ago, I sent memorials on the subject to the Ordnance, to the Trinity, and to the Treasury.

Did you send those memorials on your own authority, or by direction of the Corporation?—I got the Council or Corporation to join with me; I *wrote* the memorials myself.

All your complaints have been in respect of the Ordnance premises, not in respect of private property?—That which has been done on other property has not so much affected the harbour, it is further on to the westward.

Will not it break through into the Stour if it is continued?—It will; but perhaps not for these hundred years; the parson will lose his glebe-land very soon; he has lost 10 or 12 acres since I recollect.

What do you call the bounds of the Ipswich Water?—I must confess that in some measure they are undefined; there was a law-suit about the bounds, about 65 years ago, but it has never been completely settled.

The Ipswich Water and the harbour have each their limits, and derive their revenues accordingly?—Yes.

Do you know the amount of the revenue received for each?—I cannot challenge my memory; but the dues on a vessel's anchorage only, are only 4*d.* and for foreigners, 2*s.*; that is Harwich dues.

Do you know the amount in the year?—No.

Are there any harbour Commissioners here?—No.

Who receive the harbour dues?—The Corporation.

How are they collected and appropriated?—They are collected by the harbour master and appropriated to the current expenses belonging to the borough, to the maintenance of prisoners, and to keeping up the little paraphernalia belonging to the town; it is a very trifling amount; I think it does not amount to more than 40*l.* or 50*l.* a-year; there are thousands of vessels that come and go that never pay at all.

Who is the harbour master?—Mr. Styles, he keeps only a small skiff, and boards them at his convenience; there are thousands of vessels that go out without paying a halfpenny.

If the Ordnance ceased working the cement and built up the sea-front as Mr. Bagshaw and others have done, would that improve the harbour?—It would prevent its going back and protect their own land; but it would not improve the harbour.

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* The lord of the manor has not *a foot* of land with sea frontage, where his lessees are excavating.

Captain *George Deane.*

6th June, 1844.

What number of boats are employed in the cement trade?—Sometimes 200 or 300, but they chiefly come from Kent; but few belong to the place; sometimes there are 100 and sometimes there are 200 employed; they come and go just as they please.

How many men in each boat?—In some boats three, and in others more.

(*Adm. Dundas.*) With all the alterations now proposed, and which could be made at an unlimited expenditure, is it possible to make Harwich such a harbour that ships of any draught of water could enter and leave at all times of tide, wind and weather, night and day?—I do not think it is; at high-water they could do so, but not at low water.

What is the greatest draught of water that could be relied on at all times of the tide, day and night?—About 18 feet; but they must then be *well acquainted* with the entrance.

You are understood to say that the old channel round Landguard Point into the harbour has been much diminished in width, and you have accounted for that by Landguard Point stretching out, but you state that it has been also diminished in depth?—It has.

Is that in consequence of the point stretching over the deep water and leaving the shallow water towards the Altar, or is the present channel on part of what was the Altar?—The Altar has been altered by being a little dredged away, there is a little more water upon the top of it.

Do they go over the tail of the Altar to form part of the channel?—No; they come over the western flat of the Altar, but they cannot go over the eastern part; there is as little as seven feet at that part at low water.

There is a passage between the Altar and the point?—Yes; but very narrow.

What is the width of it?—I should think not above 50 yards; I have not measured it not having been at sea for some years.

If the beach filled up 50 yards more, it would join the Altar?—Yes.

Very few vessels go in by that passage now?—Very few indeed, but there is very good anchorage for vessels outside, when not able to sail in.

It is a safe anchorage, but not a very pleasant one?—It is very safe, there were a great many vessels there a week ago.

(*Capt. Fisher.*) Where in your opinion would be the best place to establish an asylum harbour on this coast between Orfordness and the North Foreland?—At Harwich, *undoubtedly.*

The question refers to a harbour capable of receiving ships of the largest dimensions, men-of-war and steamers, at all times of the tide?—There is no harbour on the coast capable of receiving ships of the largest size at all times of the tide.

Where would be the best place to establish such a harbour?—My opinion is that one could *not* be made for heavy ships at all times of the tide. I do not know what could be done by steam dredging; that is a modern art altogether.

In the event of such a harbour being made, could ships find the necessary supplies of water and fuel at Harwich?—Yes; I think they could, there is water at Landguard Fort, and at Erwarton also.

They could obtain water and fuel, and the other supplies they might require without delay?—Yes, by means of boats; we have some springs in the neighbourhood; we have a well belonging to the corporation, about a quarter of a mile off, where they may have their supplies freely for the fetching.

Is the anchorage-ground generally good inside the harbour?—It is very good, except close to the old ships; it is a little muddy and rotten there, but in general it is excellent ground.

(*Sir W. Symonds*).) Have you an intimate knowledge of the anchorage in Hollesley Bay?—Yes; I have anchored there many times, and know the anchorage well.

Can ships of the largest size, men-of-war as well as merchant-ships, sail through all the channels and find water at all times of the tide, day or night, from Hollesley Bay to Harwich Harbour?—Yes, to the outer part of the harbour.

Do you consider the whole of the ground within the anchorage of Hollesley Bay good?—Yes; it is reckoned fair holding-ground.

Do you consider it good?—Yes; I should say it is good holding-ground: vessels often part from their anchors there they cannot get them. I have known hundreds of vessels run up here with no anchors at their bows at all.

You consider it good?—Yes; they lose their anchors, and that is one proof that it is good holding-ground.

(*Chairman.*) How is the town supplied with water?—It is supplied from rain tanks generally; but there is a supply a quarter of a mile outside, where it can be had in dry seasons.

Is not water so scarce that the people buy it?—Yes; sometimes they do; but they may have it if they will fetch it. There is plenty of water also on the Suffolk coast opposite. Plenty of water may be found when it is required. Ships could not get it from the rain-tanks; but it may be got from Landguard Fort, from Shotley, from Erwarton, or from a well we have a quarter of a mile from the town belonging to the corporation.

And in abundance?—Yes: they used to take the water from this harbour to the North Sea Fleet during the blockade of Flushing.

Is not the distress so great that within these few days the people have been obliged to send a considerable distance for water?—They need send only a quarter of a mile from the town; the neighbourhood of the harbour would afford water to any number of ships.

Do you know what the anchorage is in what is called the Pitching-ground?—I

Captain *George Deane.*

6th June, 1844.

never rode much there; but I never knew ships drive there; they lie rather uncomfortable; but they do not drive, they have four fathoms water.

(*Lt.-Col. Alderson.*) Are not the cliffs on the coast of Suffolk crumbling away and falling into the sea, particularly about Dunwich?—Yes; I believe they are falling away there.

Does the taking of cement-stone from Felixstow tend to injure the harbour by increasing the point at Landguard Fort?—I think it has that effect.

You stated that you would prefer a breakwater run off near the lighthouse to one off Blackman's Head, do you think so because you consider Blackman's Head too low down to turn the current towards Landguard Point?—I think it would have a better effect near the Low Light, but I am not bigoted to that opinion.

(*Capt. Fisher.*) You say that ships could sail at any time of tide from Hollesley Bay to the harbour?—Yes, to the entrance or rolling-grounds.

Day or night?—Yes; particularly now that the Cork Ledge light is there.

How is it that line-of-battle ships always anchor about three or four miles down instead of coming in here?—Line-of-battle ships cannot get into the harbour, except with a leading wind at high water and they cannot come without pilots.

You have suggested a breakwater being carried out near the lighthouses in a south east direction, have you any other improvement to suggest to increase the capability of the harbour?—A little dredging on some of the shoals, the east end of the Glutton and the Altar might be much improved.

(*Capt. Washington*) Questions have been put to you, as to whether Harwich is capable of being made a perfect harbour of refuge, accessible for the largest ships at all times of the tide. You have said that it is not capable of being so made for ships of the largest size, ; is it capable of being made a harbour of refuge for ships of a smaller class? —A perfect one; I neverknew a ship to be wrecked in Harwich Harbour in my life.

Is there any Government property on the north face of the town of Harwich?—Yes; the ship-yard, and the clerk of the cheques' premises.

Would it not be in great danger, in heavy west-north-west gales, if the old ships were removed?—The ship-yard would be much inconvenienced, but I do not know that there would be much danger to the premises.

Had a solid breakwater been erected there a century ago, would it not have been a saving of expense to the Government?—It might have been, for those ships do not last above 15 or 16 years, or at the utmost 20, I have known several of them in my time, there is a sea-worm which attacks and destroys them.

Will they require other ships soon?—There is now an application to the Admiralty for another ship in place of the "Glatton," which will tumble to pieces as soon as the rough weather comes.

Was it not in consequence of such a petition to the Treasury, two years ago, that Mr. James Walker was sent down to examine?—It was in consequence of a memorial which was sent up.

(*Chairman.*) They are now digging a well to get down to the clay?—Yes; boring for water.

When was it begun?—About two months ago.

Is this the first boring?—No; they twice failed about 20 years ago.

In what way did they fail?—They never got rid of the salt water. There is a salt spring 12 feet, and another 30 or 40 feet down, and the deepest spring is the saltest.

Is there any stone in this neighbourhood from which you could make a breakwater?—No, the nearest would be the Kentish Ragstone.

[*The Witness withdrew.*]

Mr. *John Pattrick.*

Mr. *John Pattrick,* examined.

(*Chairman.*) Are you a resident in this town?—I am resident at Dovercourt.

Does any property there belong to you?—I have property there; I had freehold property abutting on the sea formerly; there stood a mill, a house in which I lived, a granary, garden, stables, &c., which I hired in the year 1817, and purchased in the year 1824. The land is now, I may say, entirely gone,—so much so, that about ten years ago I had to remove my mill, to take the house down, and all the buildings; and that I attribute to the collecting the cement-stone close in to the cliff, taking it away, and even stubbing out the cliff containing it; in fact, I have had convictions before the magistrates of the borough of parties having done so: they have absolutely taken it out of my freehold and taken it to London.

Do you sell any cement-stone yourself?—I do not; I am not allowed to take away stone, even when it falls out of the cliff.

To what extent has the land you refer to been lost?—I suppose about three-fourths of an acre.

How much has it gone back into the land?—There was a large meadow and a pond opposite to my freehold when I purchased it.

What is the space of land between the sea and the Stour River?—I should think not above four or five hundred yards.

How far have you removed your mill back?—I should think perhaps five or six hundred yards. I was obliged to remove it from freehold land to copyhold.

Is this mischief going on?—It is going on to this day.

Mr. *John Pattrick.*

6th June, 1844.

What do you think would tend to prevent it?—The shelving the cliff down.

If the taking away the cement-stone were prevented, would that remedy it?—Certainly. I have seen pieces taken out of a deep bed of stone as if laid on purpose for protection; but the men who collect on the shore go with their mauls as soon as the stone shows itself, and, being soft, it drops to pieces immediately; then it becomes the property of the lord of the manor—they say they are entitled to it. I attempted to take some of it myself, but the lord of the manor said, "I will bring an action against you immediately," though it is my own freehold; I think it is a very hard thing, possessing the freehold property, that I could not take the stone which came out of it.

Was that stone below low-water mark?—No, it is in the cliff; they absolutely maul it out of the cliff.

Is there any action brought against those persons?—I have had them up before the borough magistrates, and have had a conviction; but it was not worth while going any further, for the men could not pay more.

Have your proceedings prevented it?—No, for the men are out in the night doing it.

What steps do you conceive should be taken?—I should recommend an injunction by the Lord Chancellor, to prevent the proceedings of the lord of the manor taking the stone away.

Why do not the people who are interested take that proceeding?—It is a very expensive proceeding.

Do you expect the Government to take measures for the protection of your property?—By protecting my property, they are protecting their own; the more my property is taken, the greater the Government suffer.

What part of the Government property is injured?—The Beacon Hill, which belongs to the Ordnance. If the water makes up to our cliff, it must injure the Government cliff; the body of water is very heavy since I recollect; I have had possession of that property now 27 years.

Do you know anything of the state of the harbour?—By our cliff falling down so rapidly the earth must be carried somewhere; there is no doubt, I think, of that when the earth falls to the extent of a quarter of an acre in one lump. I have a wheat-field abutting upon it; I have now a wheat crop, but it may probably give way altogether. I contend that the cliff washing away so rapidly must fill up the harbour. I am not a nautical man myself, and do not go upon the water much; but I conceive that it must tend to the filling up of the harbour.

Do you know enough of the set of the tide to state that?—The tide, I apprehend, carries it along; it never comes back again; it is deposited somewhere or other. We have a little sand come up; at one time we used to have a good deal of stone come up, and shingle,—so much so that we used to mend the turnpike-roads from the shore; now we do not get any.

You speak of three-quarters of an acre being washed away, do you mean on one occasion?—I have known pieces considerably bigger than this room go repeatedly. I have gone round and seen a little crack in wet weather; when I have gone again it was gone; being a very stiff clay, if it once cracks, and the water gets in, it will go very soon afterwards.

(*Chairman.*) What do you think would be the remedy for that?—By footing the cliffs, and shelving them down.

Footing by what?—By a concrete wall. There is a protection by Mr. Bagshaw, now done at a very considerable expense, that stands very well; but it cannot possibly stand unless his neighbour protects likewise his portion of land, which abuts upon it. That which was my freehold is entirely gone.

How much of your freehold have you lost altogether?—It used to run in a slip; I have lost about three-quarters of an acre.

What depth of land have you lost?—I should think about 100 yards in length by 50 deep, from the sea; the vicarage land adjoins this, which I hire from the Rev. Mr. Bull. I took it at a certain rental; the cliffs were falling so rapidly, and I was losing so much ground, that I applied to him for a reduction of rent, and he allowed me 5*l.* a-year in consequence.

How long has this practice been going on?—I have known it 27 years.

Was it so before they began to remove the cement-stones?—No; they were removing cement-stones, but not to the same extent as they are now.

Do you know that they were removing it at that time?—Yes.

(*Admiral Dundas.*) How many years have you resided there?—Twenty-seven years; from the year 1817.

Did you, on your first taking it, know that the cliff was washing it away?—I could scarcely perceive it then; I had some property below, abutting upon the sea, below the vicarage. I hire 170 acres of land of Captain Deane, where I am obliged by my lease to keep up the sea-wall, when I took my farm 14 years ago. I have a heavy expense in keeping up those sea-walls; now, at the time I took it, the expense was scarcely 5*l.* a-year.

If you, when you first took possession of your property in Dovercourt, had commenced by making a sea-wall, would you have prevented the mischief?—No doubt I could have protected it, as far as my own went; but if my neighbours did not take the same measures, mine would have been ineffectual.

That is not the case with Mr. Bagshaw's land?—It is not wanted at present; but I apprehend it will be.

Mr. *John Pattrick.*
6th June, 1844.

If the landowners had taken measures to protect the foot of their property, would not that have had an effect in saving the property?—They might have done it to a degree; but the lord of the manor threatened actions.

Then what they ask to be done is that which they ought to have done for themselves; unless it can be shown that it is a public nuisance, can they expect that?—The lord of the manor threatened proceedings against any individual who would attempt to put shies or footings to protect their property.

On what ground did he threaten?—Because we had no right to put a stick on the shore.

Who is the lord of the manor?—Mr. Garland, who has a country-seat at Ramsey Hall, but is very seldom there: he lets the shore off; he used to have five or six hundred a-year for the cement-stone, but now they cannot get so much as they used to do; they excavate within 10 or 12 feet of the cliff; they go to the cliffs, and they get them out. I suppose that the rental is not above 300*l.* a-year now.

Having exhausted under water, they now get it out of the cliffs?—Yes.

Is he lord of the manor in which Mr. Bagshaw's property is?—Yes.

He has not prohibited Mr. Bagshaw?—No, he has not.

(*Chairman.*) Was there any allowance made to you to build a wall?—No; but there was a large meadow in front, with a large pond (which was the Wix Church's land); I used to go from my field into the barrack-ground.

You bought it with your eyes open?—Yes, of course.

If you had built a sea-wall as Mr. Bagshaw has done, you would not have lost your property?—I called on Mr. Bull, but, being incumbent for life, he would not do it, only having a life interest; and my neighbour on the other side would not do it.

Do you think that the sinking of the cliffs has injured the harbour?—I think it has.

What is the depth of the soil of your farm?—I suppose 15 or 20 feet, but the cement-stone is mixed with the clay.

How low is your ground?—The earth is 15 feet down to the stone at the bottom.

[*The Witness withdrew.*]

Mr. *Edward K. Calver, R.N.*, re-examined.

Mr. *Edward Killwick Calver.* R.N.

(*Chairman.*) How long is it since you were engaged in the survey of this harbour?—Two years.

Have you compared your survey with any of the old charts?—I have.

Charts of what date?—1709.

What is the difference you discover between the chart of 1709 and your present survey?—A considerable increase in the extent of Landguard Point, and a proportionate decrease of the Beacon Cliff.

To what extent has Landguard Point gone out in that period?—500 yards

To what extent has the Beacon Cliff worn away?—500 feet.

You state that on comparing the two charts?—Yes.

Have you compared those with more recent charts?—The next is 1752.

What is the difference between 1752 and the present time?—I have no record of the state of Landguard Point; there is no document to be relied on prior to Græme Spence's, which was in 1804.

What is the difference as to Beacon Cliff?—Beacon Cliff is diminished in extent 450 feet since 1752.

What do you suppose to be the occasion of this washing away of Beacon Cliff?—The quarrying of cement-stone at the foot of it.

Do you know when the quarrying began?—I have heard, 30 years back.

You have stated that the increase of the Landguard Point and the diminution of Beacon Cliff was in full operation before the removal of the cement-stone?—No; there was a small decrease in Beacon Cliff. We have no record of the other side.

What do you suppose has occasioned the lengthening out of Landguard Point?—The decrease of the scour caused by the diminution of the Beacon Cliff and the rocks at the foot of it.

Meaning thereby that the tide has a greater spread?—Yes; the tide, which formerly was thrown into a deep-water channel close round the beach, is now lost over a useless space to the southward.

Do you think that the increase of the Point is occasioned from the shingle coming round from the north-east on the outside, and that the want of scour enables it to grow up?—I think that the want of scour is the cause; the want of scour has allowed the shingle to tail on.

If groynes were placed there in sufficient number, do you not think that that would prevent any further increase of the Point?—It would till the beach had accumulated at the ends of them; this would occur in the course of years, according to the number of the groynes.

What would you advise to be done to prevent further encroachment on the Beacon Cliff?—I would join the Cliff-foot Rock to the Beacon Cliff by a breakwater.

What would be the effect of that, in your opinion?—On the ebb-tide the water which now wastes itself over a useless space to the southward would be concentrated, and

Mr. *Edward Killwick Calver.*

6th June, 1844.

serve to keep stedfast the main channel into the harbour. At present the ebb-tide out of the harbour is lost to the southward.

Suppose the useless space along the Ordnance property to be enclosed two or three feet below the low-water line, would not that give a fair current to the tide out and an increased current in?—It would increase the current a little at the first-quarter ebb, but would have little or no effect during the remainder of the tide.

Why so?—Because it is already a flat, elevated a considerable number of feet above low water; it would not give the required direction to the scour; the scour is wanted more to the eastward.

The object of that which you propose by the breakwater is to act on Landguard Point?—Yes.

Will not the removal of the beach take from the protection of the harbour?—I do not think that any increased scour caused by the erection of a breakwater would have the effect of removing the beach; it would merely hold it stedfast, and prevent its accumulation westwards.

You would check its growth but not diminish it?—I would not diminish it; it is, in fact, a benefit.

Would you not be lessening it by throwing such a scour on that point?—No; I do not think the scour would have that effect; it would prevent its accumulation, but I do not think it would diminish it; if the Channel was contracted considerably it might; but a great part of the breakwater is projected on a site where there is little depth of scour.

If you contract the Channel so much you must throw the great weight and power of the scour upon Landguard Point?—Looking at it, I think the capacity of the entire Channel is decreased about one-fifth, not more.

Why so?—On account of the shallowness of the water near the position of the breakwater. Between the Cliff Foot and Landguard Beach is the main channel for the scour at present, and that has a depth of 22 to 16 feet, but the space proposed to be enclosed is only of a general depth of from 2 feet to 10.

You admit that enclosing the land along the Ordnance front would have a good effect to a certain extent, but not to the extent required?—Yes.

Would it not have the effect of securing the whole of the Ordnance property, and saving that from waste?—It would have that effect, besides improving the channels generally.

Is it not a safer course to adopt a plan of that kind than to take the risk of what might be the effect of the very narrow channel which is proposed?—I do not think it at all likely that enclosing the dry space between the town and the Beacon Cliff would have sufficient power to bring about the effect required; it would have a slight influence at the first turn of the tide.

Will not the enclosure in front of the town of the Ordnance property be restoring the boundary in that direction to its original and natural form?—It is the space at that point which has been taken away.

Is there anything else which you would suggest to be done to improve the harbour?—I would dredge away a portion of the shoals in the eastern channel the Altar and the Glutton End.

Do you know of stone being removed from any other part but from the front of the Ordnance premises?—Some ledges abreast of Felixstow were removed.

Has that occasioned any mischief?—I should think that that alone would have done little mischief, if nature had not been disabled (by the removal of the Beacon Cliff) in the only means for overcoming it.

(*Sir Howard Douglas.*) Do you think that the Altar Shoal is diminishing in size now?—We have no good document of reference to determine.

Have you ascertained of what the Altar Bank is composed?—It is a general collection of mud, gravel, and cement-stone.

Is any part of it deposit from the peculiar direction of the current?—I should think the main portion of it (or the Flat of the Altar) is deposit; but the Altar itself appears to be nearly all rock.

To what point do you think the breakwater should be run out?—If it is run out too short, I think the effect will be lost before it comes the length of the Channel round Landguard Point. It ought to run from the Beacon Cliff to the inner part of the Cliff-foot Rock, so as to make use of the Cliff-foot Rock itself as a continuation of the breakwater.

Then why not carry out the breakwater to the outer part of that rock?—Because the effect would be nearly the same without the erection; for the principal part of the rock is only two or three feet below low-water level.

Of what material is the Glutton Bank composed?—The upper part deposit; I cannot answer further than that.

If a more active current could be thrown over those two banks (the "Bone and Gristle"), part of that which has been deposited would be carried away again probably?—It is of too tenacious a quality to be affected by an increased current.

But being deposited by the current, there is a particular velocity which would take it away again?—The velocity must be very much increased to effect that.

(*Admiral Dundas.*) With all the alterations now proposed, and if made at an unlimited expenditure, is it possible to make Harwich such a harbour that ships of any draught

Mr. *Edward Killwick Calver.*

6th June, 1844.

of water could enter and leave it at all times of the tide, wind and weather, night and day?—It is possible to improve it to any extent; but it may be improved at a small expense for all necessary requirements.

What is the greatest draught of water which could be safely relied on now for a ship running in at all times of the tide, night and day?—12 feet.

With the improvements which you suggest, what additional draught of water would you give?—15 feet.

Your object in making the proposed breakwater is to contract the outlet on that side, and thereby to increase the rapidity of the current?—It is.

Any other means which would produce the same effect would answer equally well?—Yes.

How long have you been employed on this station?—From two to three years.

Have you any other knowledge of this coast than that which you have derived during your time of survey?—For a period of eight years I have been constantly employed surveying coasts and harbours; on this particular coast I have been only three years.

(*Captain Fisher.*) Are you aware whether ships-of-war and merchant-ships of the largest class can approach this harbour from Hollesley Bay at all times of the tide, in any weather?—They will pass over the shallowest water between the Andrews and the Inner Ridge Buoys in a depth of 19 to 20 feet at low water.

Are there marks at present during the night for navigating those channels?—Ample.

Are you of opinion that a harbour of refuge to answer all the purposes described could be made in Hollesley Bay?—For heavy vessels, I believe it is perfect at present; but for small vessels, it would require a considerable outlay; it is possible to make it a middling harbour for small vessels.

Is the general anchorage-ground good in Hollesley Bay?—I have not a thorough knowledge of Hollesley Bay; but from the experience I have had of it, it is very good. With a short scope of cable while riding in Hollesley Bay in October last, we dragged the chain through the windlass.

(*Chairman.*) Is Landguard Point composed of the same material as that which you have mentioned as the Beacon Cliff, or what is the substance which might be removed by the scour arising from the contraction of the entrance by the breakwater which you have suggested?—I do not think it would have the effect of causing any removal at all.

What will be the rate of the tide acting upon the Point, in your opinion, if this breakwater is constructed?—From three to three and a half knots.

What is the rate now?—Two and a half.

That will make a knot difference?—Thereabouts, I should think.

What is the depth of the Channel coming into the harbour at low water?—Twelve feet by the usual channel; but I could bring in a steamer drawing 18 feet by the deep water channel.

What is the rise?—Twelve feet.

Making twenty-four?—Yes.

Speaking of spring-tides?—Yes, the springs rise from eleven and a half to twelve feet.

Do you think that by any process it is likely to be made accessible to ships-of-the-line at high-water?—The erection I propose, with the alterations in the eastern channel, would make it accessible to ships-of-the-line at high-water.

Do you think it would make it accessible to ships-of-the-line at high-water neap-tides?—To ships drawing as much as 22 feet.

How do you propose improving Hollesley Bay for small vessels?—I would not, in fact, do anything at all there, though it is possible to improve it by raising the level of the Whiting.

At low water how much of the Whiting is seen?—I have not a thorough acquaintance with it, but I do not think that any part of it is dry.

What is the worst wind in Hollesley Bay?—From east to north-east.

A ship anchoring to the westward would be sheltered from the east-north-east wind?—Partially.

The way in which you would improve Hollesley Bay for small craft would be by putting an embankment on the Whiting?—Yes, but it would, after all, be imperfect as a harbour of refuge.

(*Capt. Washington.*) Is there any point of this coast where a harbour of refuge could be formed for admitting all sizes of ships, in all times of the tide, wind, and weather, night and day?—I think Harwich offers the greatest advantages, taking all things into consideration.

What was the old leading mark into the harbour round Landguard Point?—Walton Black Granary, on with the west window of Walton Mortella, in a depth of from 5 to 7 fathoms at low water.

Where would that mark lead now?—Through beach elevated 7 feet above high-water spring-tides.

What date are you speaking of that you could have sailed by the mark you have mentioned?—The year 1804, and I think as late as 1820; I am speaking of what I have heard from various authorities.

[*The Witness withdrew.*]

Lieut.-Colonel *Henry Vavasour*, R.E., examined.

Lieut.-Colonel *Henry Vavasour*, R.E.

6th June, 1844.

(*Chairman.*) How long have you been in command of this district?—Since June, 1841.

Have you ever known during that time of any representations of mischief done to the harbour by taking away the cement-stone from the Ordnance premises?—Yes; two memorials; I can give the reports that have been written upon that subject from the year 1825, with the opinions of Colonel Fanshawe, Sir George Hoste, and myself, up to a very recent period.

What has been the effect of those memorials?—The reports on the memorials do not refer so much to the harbour as they refer to the Ordnance land, because they were not called for by the Ordnance, with reference to the harbour only. This arose in the shape of protection to the cliff and Ordnance lands, but there is no doubt that the allowing the Beacon Hill to waste as it has done for a series of years has affected this harbour to a very material degree. Any one who watches the way in which nature performs her part, cannot fail to see that if the stone had been allowed to remain as it was some time ago, the harbour would be in a different state from what it now is.

Did the cement stone form a barrier?—Yes, it narrowed the channel of the harbour, and it gave a greater force of action to keep the harbour's mouth clear; *now* the ebb-tide is diffused over a very large surface, and materially weakened. The deepening of the harbour has never been brought before me as a professional man; it is only from viewing it, and from the different publications I have read, and conversations I have had with old seamen that I have formed my opinion. The harbour has been injured from another cause. There was a projection of rocks between Landguard Fort and the Deben River; that rock threw the shingle which came from the northward in a south-easterly direction, thus carrying it away by the flood-tide (this is my own idea, I do not assert that it is correct); thus the major part did not come down to Landguard Point. The rock being moved, allows the whole of the shingle to creep along the beach, and increase Landguard Point. Landguard Point, on General Mudge's Plan (the Ordnance survey 50 years ago) runs close round the Fort. At present it is some hundred yards extended into the sea. I doubt whether there are not, at some period of the tides, two forces acting in a manner to produce still-water near the Point, and thus the sand and shingle suspended in the still-water are deposited, and increase Landguard Point.

How has that rock been removed?—I cannot say from my own knowledge, but I understand for the purposes of cement. To stop the increase of Landguard Point, I would carry out a mole to throw the shingle, which now moves down from the northward into deep water, so that it may be carried down Channel by the tide. Before the rocks were removed, Landguard Point did not increase. It appears to me to be prudent, on such occasions, to follow as nearly as may be the principle on which nature acted successfully.

How would you improve the entrance to the harbour?—I should propose to carry a pier from the point of Beacon Hill to the Cliff-foot Rocks. I should myself prefer to take it from the Lower Lighthouse rather than from the Beacon Hill. I would rather carry it from the Lower Lighthouse to the Cliff-foot Rock. It is very evident that this will contract the harbour's mouth, and of course increase the power of the ebbing tide.

Restoring by artificial means what has been taken away from the front of Beacon Hill?—Yes; this was a very excellent harbour, and it has become injured by quarrying cement-stone in front of Beacon Hill.

Following up your idea of not interfering with the operations of nature, would not the bringing forward a wharf along low-water mark in front of the Ordnance property tend to restore the former state of things?—That was my first idea, but nature will raise part of the land between high and low-water mark; if you erect the breakwater from Beacon Hill; and this also (Mill Bay) will fill partly, as there will be still-water there.

As a work immediately to be undertaken, would you recommend enclosing the front of the Ordnance property, as well for the sake of the protection of the Ordnance property as for giving full vigour to the tide?—I think I would carry out a breakwater first, for the other can easily follow; that will improve the current immediately.

You propose, then, a simple breakwater?—Yes; no doubt the enclosing part of the land between high and low-water in front of the Ordnance property would be a better thing, provided the wharf continued as a mole to the Cliff-foot Rock; I should take it out to the edge of the deep water.

That would occasion a great additional expense?—I am aware of that, and therefore I proposed the breakwater.

Might not the contraction of the harbour to that extent act with so much force upon the Landguard Point as to carry off the beach, and expose the harbour more to the sea?—There is no doubt it would expose the harbour more to the sea if the point is carried off, and the mouth enlarged.

Do not you suppose it would have the effect of taking off the point?—There is no doubt it will take off a portion of the point; but I have doubts as to the effect of running streams, whether they will affect materially the beds of harbours, &c., &c., at certain depths of water. I think you must dredge first, and the current will keep the harbour's mouth clear. But I do not know of any experiments tried to show how currents affect the beds of rivers. I believe you will have to dredge in the first instance; but I have no experience on which I can base that opinion.

(*Sir Howard Douglas.*) If the breakwater is taken out and it acts too rapidly on the Landguard Point, that cannot be remedied?—The object is to go back to nature.

Lieut.-Colonel *Henry Vavasour*, R.E.

6th June, 1844.

The erection of a breakwater does not appear to be following nature?—In its effect I think it is.

You do not think that simply increasing the shoal in front of the Ordnance property would be sufficient?—No; the current cannot afford to lose a single particle of force, which it must lose should such plan be adopted in preference to carrying out one of the two works proposed. I have read with great attention this paper of Captain Washington's which has been sent to me, referring to the loss of land and the damage in consequence, and I beg to say that I concur in every word which he has written. If the Commissioners wish to get information with regard to the protection of the Ordnance lands, I can afford it. I have gone on gradually erecting groins, but the Ordnance do do not grant money sufficient to erect all the necessary groins at once; they have this year granted 350*l.* and last year 300*l.*, and the year before 300*l.*

You consider that the injury to the harbour arises from the formation of the shingle, and that that has been occasioned by the removal of the stone at Felixtowe?—The injury to the harbour has arisen from two causes, viz., the removal of cement-stone from the front of Beacon Hill, and the removal of stone from the cliff at Felixstowe. The supply of shingle comes from the northward, and unless you stop that supply it will still come; you cannot destroy the power which brings that shingle down, and you do not give the shingle a different direction.

Would a breakwater along the shore tend to preserve the Ordnance property?—Decidedly it would; but the Ordnance property will be so protected by the groins which are being put up that it is not necessary for Ordnance protection; it might tend to secure the property to the use of the town. The Ordnance might probably be induced to place the main defence in advance; I, as an officer of engineers, would rather have it higher up with batteries *à fleur d'eau* in front.

(*Chairman.*) It has been stated that great injury is done in Mill Bay by the cliff wasting away in consequence of taking the cement-stone, and that the distance from thence to the Stour is only 380 yards; do not you apprehend great danger if something is not done to check that?—Most undoubtedly, taking away the cement-stone tends to admit the sea to destroy the cliff; but I think the major part of the injury is already done; they have taken away almost all the stone they can get they are now going down four feet to dig up the stone at that level. They say they do no mischief by digging such holes; but I think if every point of the plane is lowered, that is lowering the whole plane certainly. I have endeavoured, as far as I possibly can, to stop the digging; but the Ordnance have granted a lease to Mr. Alder, the cement manufacturer, and they cannot prevent the digging unless they grant a new lease. I suspect that to prevent the quarrying on Mr. Garland's manor the Government will be obliged to go to the House of Commons. The manor, I believe, is let. Some of the people round complain that their property is injured. I wish to add to the evidence I gave, that in 1842 I put up groyne, marked No. 1 on plan, which now effectually protects the part of the cliff where the sea made the first advance on the river Stour. Late in 1843 I erected Nos. 37, 38, to protect the left flank of Mr. Bagshaw's property. These last are collecting beach and will protect the foot of the cliff in due time. Thus the sea will not advance on the River Stour, as apprehended, through that part of the Ordnance land.

Do they take away the necessary measures to prevent it?—I do not know whether they have taken any steps to prevent the quarrying. To protect their cliff by a wall is an expensive work. An officer of engineers sent in an estimate of the expense at 33,000*l.* If the committee will walk across the Barrack Field, they will see how thoroughly and effectually some of the groynes protect the cliff.

It is in evidence that the people have taken away the stone in the night-time?—I do not know what is done on private grounds. I brought one man before the magistrates, and he was fined for stealing stone at night; now it is not taken from the Ordnance land within the 50 yards reserved.

Where do they get the cement-stone now?—From the West Rocks, the Ordnance manor, and Mr. Garland's manor; they buy it at 3*s.* 6*d.* Ordnance stone, and 4*s.* 6*d.* West Rock-stone a-ton. There are 50 yards reserved from the foot of the cliff, of which I am the guardian, and I preserve the stone on that portion.

(*Admiral Dundas.*) You were understood to say you would leave it to nature to restore this harbour?—No; I would restore to what it was as far as I could, when it was a good one before nature was altered.

Was it a good one before those old ships which lie there were moored off the town?—That I cannot tell; they were there when I came.

Have the Ordnance power to put an end to the lease?—Yes; by giving six months' notice; I believe the lessee would be willing to execute a lease leaving out the power to take cement-stone from the Ordnance manor.

What would you do?—Stop their taking any stone from the Ordnance manor. I can speak only as to the Ordnance manor.

The lessee pays 300*l.* a-year for his premises, with permission to work any part of your ground except 50 yards from the cliff?—Yes; he may go anywhere he pleases in the manor within the points named in his lease.

Do you apprehend he gets many cement-stones from the Ordnance premises?—He gets very little now, for he has taken almost all he could take.

That is the reason probably why the rent was reduced from 500*l.* to 300*l.*?—I cannot say; that was before I came here; there was a great abundance of stone formerly.

Lieut.-Colonel *Henry Vavasour*, R.E.

6th June, 1844.

To show this there is a ledge of rocks mentioned in one of the Reports, and the officer writes, "At the extreme south point it is not probable that the sea will ever throw up sufficient materials to form a beach over the ledges."

(*Sir Howard Douglas.*) What is the date of that Report?—The years 1826-27. Here is the decrease from time to time of the land of the Ordnance (*showing it on the plan*). In 1709 that was the boundary (*pointing it out*); that in 1745; that in 1809; that was the state in 1830; and this was the one I put in myself in 1843 (*pointing out the spots*).

Would the breakwater you suggest from the lower light do away with the necessity of those groynes you have referred to?—Of some of them certainly, if done immediately.

Have you any idea of the expense?—Each of the groynes 150 feet long cost 84*l.*

How many is it proposed to have?—25.

Would not the necessity for the whole be prevented by the breakwater?—Not of some of them; but if they are not put down immediately the land will go.

The carrying out of the breakwater would have the effect not only of deepening the channel but of preventing the necessity of the erection of the groynes?—Yes; of deepening the channel and saving some of the groynes; that is my opinion decidedly.

What is the length of the groynes?—150 feet; I first had them 100 feet, but I have added 50 feet; but they need not all be the same length; that depends on their situation.

(*Chairman.*) Do you know whether there is material in the vicinity of Harwich suitable for the construction of such a breakwater as you suggest?—No; there is no stone about us; the cheapest way would be to get the Kentish Rag-stone from the neighbourhood of Maidstone.

What depth of water would the channel have with the alteration you propose?—You might bring it to any depth, it might be brought to its old depth, which was seven fathoms, by dredging, and the current will then keep it open.

(*Lieut.-Col. Alderson.*) Though they are not working the cement-stone within 50 yards, the bank still goes?—Yes; because where there are no groynes, the sea washes the foot of the cliff. There is not a large portion of stone on the 50 yards. The lower the height of the plane extending from the foot of the cliff seaward, the greater the injury to the cliff from the action of the sea; by removing cement-stone the plane has been lowered, and a greater body of water advances to attack the foot of the cliff. Before the quarring, that plane was high; now they have lowered it, the advancing wave comes up with more force to the cliff.

[*The Witness withdrew.*]

Mr. *Lewis Cottingham*, examined.

Mr. *Lewis Cottingham.*

(*Chairman.*) What is your situation?—I am a plumber, and the owner of small vessels.

Are you constantly resident here?—I am; I am a native of the place.

Are you aware that any injury has been done to the harbour of late?—Yes.

To what do you attribute that?—I attribute it to two causes; first, the removal of two natural breakwaters, namely, the ledge of rocks from Felixstow Cottage, commonly called the Governor's Cottage. The removal of that barrier, I conceive, altered the course of the current; at the time the ledge of rocks remained it threw the current to the southward away from Landguard Fort; the removal created an eddy which caused an accumulation at Landguard Point. The other cause was, the taking away of the cement-stone on the Harwich side, which has also caused an accumulation on Landguard Point; at the time the barrier existed it kept the tide to the eastward towards Landguard Fort, and by that means the Point was kept clear as it had been for at least 100 years. Then there is the removal of a natural ledge of rock-stone which projected from the Beacon Point, which was commonly called Blackman's Head, that was formed up to the height of from four to six feet; there was a considerable quantity of cement-stone removed from the Ordnance and manor containing, I believe, 355 acres, including 80 acres of Ordnance shore, which has occasioned much mischief.

How long has that mischief been going on?—I consider about 18 years.

You had not been sensible of anything of the kind before that?—No; my opinion is, that the cliff did not go so rapidly; it would go of course in a degree from the exposure to the wet and the sun, and so on; but the removal of this natural breakwater (the cement-stone) has caused it to go at a rapid rate. An uncle of mine, who is now 80 years of age, who owned that property which Mr. Bagshaw has lately fortified with concrete, felt so satisfied of its safety that he built houses upon it.

What would you recommend as the remedy?—To carry out a breakwater from the point of Beacon Cliff to the extent of from 500 to 800 yards. I consider that that will throw the tide over to the eastward, and would prevent Landguard Fort Point further progressing,

Do not you think the effect of the tide would be the washing away of a part of Landguard Point?—No, I think not; but it will keep it clear: it may possibly have some tendency to diminish it, but I think not to any extent.

Suppose the front of the Ordnance property to be enclosed, would the effect of that be better or worse?—I should rather fear the effect of that; my conviction is, that a

Mr. *Lewis Cottingham.*

6th June, 1844.

breakwater from the Beacon Cliff would have a better effect. I think it would throw the tide over, and have an effect on Landguard Point by stopping it. The enclosing the frontage, I think, would have a tendency to create an eddy which might be unfavourable, and probably cause a breach between the Boat House and Landguard Fort.

(*Admiral Dundas.*) Has Mr. Bagshaw's wall completely sustained his land?—It has; my uncle, who previously owned the property, put up groynes; but he received a notice from a solicitor threatening him with an action, and that deterred him from continuing those groins, and induced him to sell the property at a great sacrifice, the houses being in great danger unless they could be protected.

At what draught of water can a ship enter the harbour now at all times of the tide?—In its present state, a ship drawing twelve feet only; but I am not a sailor; I have merely a pleasure-boat, and am occasionally on the water.

With all the improvements which you would suggest or which you have heard suggested, what would be the difference in the draught of water?—It would at least maintain three fathoms.

Do you think a ship drawing 18 feet water could come into the harbour at all times of the day and night after the improvements?—Yes, I am confident of that.

You have no knowledge of the depth of water in the channels?—Yes, from coming over in the packets occasionally, and from sailing out with my vessel (about 20 tons) over the shoals to ascertain the nature of the soil, and sounding the channels at the time. I also take the management of the tide-gauge for Captain Washington; and can tell what depth of water at any time there is in the channel by reference to the gauge.

Do you know how many men are employed in the cement concern?—I should say from 400 to 500.

Do they live entirely by it?—Yes.

What is the number of vessels out of Harwich employed in the North Sea fishery?—At present not more than 10; formerly there were 60 or 70 sail.

Has the number much diminished of late?—Yes.

At what period were there 60 or 70 sail?—About 30 years ago.

What has been the cause of their falling off?—From parties who were in the trade dying, and others not taking it up; and every year there used to be one or two vessels lost on the Dogger Bank.

Is it not the fact that there is a greater spirit of enterprise on the part of the Dutch?—I am not aware of it; but there may be.

Perhaps those engaged in it have got too rich?—That may have had an effect on some.

Have they not found the cement-trade pay better?—I do not know; there has been so much competition in that trade; it may pay those who have purchased the stone, perhaps, but not those who dredged it up; I am not aware of any smack-owner embarking in the stone-trade.

(*Sir Howard Douglas.*) Is it understood that the proposed Railroad Company will give 30,000*l.* towards constructing the pier?—That I have understood.

Do you know it from any authority?—I have heard it from the chairman of one of the Companies.

Do you believe it?—I have an assurance from Mr. Duncan, the solicitor of one of the Companies, that they will expend that sum, and the construction to be under the approval of the Admiralty; and I believe Mr. Duncan has sent a written statement to that effect.

Do you attribute the falling off of the fishery, or of trade generally, at Harwich, to any deterioration of the port?—Not at all.

Would there be any difficulty in dredging away the shoals in the harbour to the depth of 15 or 20 feet?—I consider, not any. I have recently been on the Committee for dredging the harbour, and we have set on a dozen boats for the purpose of ascertaining what could be done by dredging, and have got 518 tons of soil composed of clay, mud, and cement-stone; and there is about one-eighth of cement-stone which they have collected. I feel quite confident that those dredging-boats will reduce the shoals and give a much greater depth.

Can that be done by local vessels?—Yes. There is now lying on the shore at least one-eighth part more of small cement-stone, also the same quantity of copperas (which has been collected by the boats), which the Harbour Committee had employed men to collect. The copperas-stone is worth 6*s.* per ton, after paying expenses of the freight to the Chemical Works at London; but in consequence of the Commanding Royal Engineer at this port stopping the workmen from collecting it, at present the value of it is lost. It would, if sold, reduce the expense of dredging the shoals more than one quarter.

(*Capt. Washington.*) Do you think that the Altar Bank or any shoals thereabouts are formed by deposit from the river?—No, I think the Altar Bank and the Altar Flat are a formation from the cliff, which was a continuation of the land, and the cement-stone was part of the formation from the natural soil.

Do you happen to know how near beneath the surface cement-stone is found?—The cement-stone runs about six feet from the surface of the cliff; if you take up the surface of it by going from four to six feet down, you come to another; and at some parts only two feet.

You say that 500 tons have been dredged up?—Yes.

Do you think they have deepened six inches in doing that?—Yes.

Mr. *Lewis Cottingham.*

6th June, 1844.

Do you know the fact?—No, I compute only from the quantity of yards, 518 cubic yards.

Do you think that they have dredged to the extent of one foot?—No.

You believe that they have brought up 70 tons of cement-stone in dredging?—Yes.

Is there any Government property on the north face of the town?—Yes.

Would it not be in great danger if the old ships were removed?—Certainly. The old ships placed, on the north side of the town for breakwaters, are of first-rate importance in several points of view: they form a defence to the quays and Government property. By them an inner or safety harbour is made, without which there would not be a safe spot to lay ships ashore for delivery of their cargoes or for repairs. The breakwater ships are supports for Her Majesty's revenue cutters and other vessels requiring their bottoms cleaning or examining; and it is a well known fact that the revenue cutters on the Yarmouth station have come to Harwich for the purpose of using this accommodation, which could not be obtained there. The decks of the breakwater ships are also useful for depositing the stores, and for preparing, stretching, and serving the rigging of the vessels when refitting.

Had a solid breakwater been erected there a century ago, would it not have been attended with a great saving to the Government?—There is no doubt of that.

(*Chairman.*) Are the vessels in a sound or a bad state at present?—In a bad state; the "Glatton" particularly is in a very dangerous state; and if she is not removed soon, and a pier or a breakwater erected in her place, there will be great danger to the Government property, and the north part of the town; but for those ships, the greater part of the north face of Harwich would have been washed away.

If the Government keep possession of their property, the building the pier will be the cheapest thing?—Yes, certainly it would be the cheapest thing to erect a solid breakwater at once.

If Mr. Rendel's plan of a breakwater and a pier on the north face of the town were carried out, would it not afford ample protection and enable steamers to land their passengers at all times of the tide?—Yes.

Is it your opinion that 30,000*l.* will do that?—Yes, it is.

How much money has been expended in the dredging by the dredging-boats you have referred to?—At present we have expended 98*l.* 15*s.*

At what depth will your dredging-vessel work?—Any depth required.

Are the lips of the buckets powerfully armed with steel?—Yes.

Have you two sets of buckets?—Yes; each boat uses four.

You have raised 518 tons?—Yes.

In that do you take credit for the sale of the cement-stone?—Yes.

What did you get for the cement-stone?—We got 14*l.* 17*s.* for the stone.

(*Capt. Washington.*) Was not the sum of 100*l.* voted by the corporation for the express purpose of proving to the Harbour Commissioners and the Admiralty that the shoals could be easily dredged away at a very trifling expense?—Yes, I was one of the Council who voted for it.

(*Mr. Walker.*) You have referred to building a breakwater or pier, of what materials would you propose building that?—I propose building it of Maidstone or Kentish rag-stone, in length 800 yards, breadth 8 yards, and the mean depth 4 yards, which I find will amount to 25,600 tons; that, at 5*s.* per ton, will amount to 6400*l.* for the stone only.

What do you take for lime and building, and so on?—I consider that a dry pier would have the effect.

Have you an estimate of the total cost, including building?—No, I have only the amount of what they would bring the rag-stone for.

What would they lay it at?—I suppose 6*d.* per ton.

Have you made any estimate of the cost of such a pier?—No, I consider that the expense of placing the rag would not be great, not more than 6*d.* per ton; but I am not an engineer.

Have you made an estimate of the whole cost of such a wall?—No.

[*The Witness withdrew.*]

Mr. *Richard Hales,* examined.

Mr. *Richard Hales.*

6th June, 1844.

(*Chairman.*) What is your occupation?—I am clerk in the Royal Naval Yard.

Do you consider the ships that are sunk at the end of the town necessary for the protection of the harbour?—I do.

Do you think it highly desirable that the breakwater proposed by Mr. Rendel should be constructed?—I do, for the following reasons; namely, as a protection to the sea-faces on north front the wharves of the Government-yard and that part of the town where, from raging weather and spring-tides the sea makes a breach over them, and must in many instances, have been destroyed but for such protection. And again, the present contracted convenience of shelter in the inner harbour or pound; that of lying vessels on shore to examine their bottoms for cleaning or repairs, which, from the state of the weather, cannot be done at all times, as when the winds are raging from the north-west to east, which Mr. Rendel's proposed pier would amply guard against. I beg to offer a few remarks upon its further advantages: revenue cutters are often ordered up from Yarmouth

Mr. *Richard Hales.*

6th June, 1844.

to survey their bottoms and examine defects which cannot be done at that port, it being a bar-harbour; also Government vessels generally, and even the surveying steamers which are stationed at this port, might be accommodated, and likewise take on board their supply of coals without delay, alongside the pier at any time of tide. And being the only port of refuge on the eastern coast, it frequently occurs that mail and other steamers are driven into this port for shelter and supply of coals which have now to be sent off in boats in boisterous weather, which occasion great delay. During the winter seasons numerous damaged ships, from getting ashore or otherwise are brought into this port, which require their cargoes to be discharged, and the state of the ships examined, which many of them, from their draught of water and water-logged state, cannot be laid in the present constituted inner harbour or pound. And it has occurred that ships under the circumstances I have mentioned, have been towed by steam to the port of London, when, from the facilities now offered by the proposed pier by Mr. Rendel, the removal of ships would be obviated.

The Railroad Company have agreed to give 30,000*l.* for that purpose?—So I understand.

Are you not on the Committee?—No.

You have merely heard that?—I have only heard it mentioned.

Supposing a pier were not to be built, will it be necessary to have some more ships sunk there?—Yes, the ships are getting into a decayed state now; it will be necessary soon to replace them.

Without that what would be the effect?—The effect would be that we should lose part of the Crown property; the sea would have such an effect upon it, it would range it away.

Do you think that the sinking of the ships there has had an effect on the tide injurious to the harbour?—I do not know that their lying there has had an effect injurious to the harbour.

Has their lying there altered the tide so as to produce injury?—Not that I am aware of.

What do you consider the cause of the injury to the lower part of the harbour?—I consider the falling away of the cliff, and the taking away of the cement-stone to have produced it.

In what way do you think that could be best remedied?—By constructing a pier or breakwater from where the present ships lie sunk, and continuing it up to the westward.

From whence do you propose having the breakwater proceed?—I should continue it out in the present line and bring it into the river, and more round to the easternmost part of the harbour.

What is your object?—To turn the tide; but I did not expect to be questioned upon this, only the inquiry to the town and Government yard.

What number of old ships have you known used here from time to time?—I have known 13 old men-of-war in my time.

What number of years?—Fifty years.

Frigates and sloops?—Yes, there have been two sixty-fours and the "Glatton."

Do they fill them with stones?—We sink them and scuttle them, and put ballast in to keep them down.

What did they cost you?—The ships are supplied by Government.

Have you any knowledge of the navigation of the Channel either into the harbour or leading into the harbour?—No; my knowledge is confined more to the Government yard.

[*The Witness withdrew.*]

John Chevalier Cobbold, Esq.

John Chevalier Cobbold, Esq., examined.

(*Chairman.*) In what profession are you at Ipswich?—I am a banker at Ipswich, and interested in mercantile affairs in Ipswich generally.

Are you enabled to give the Commissioners any information with respect to Harwich Harbour?—Is the inquiry as to the importance of it to the port of Ipswich?

Is there anything you can state as to the improvement of the harbour?—I do not know that I can give any suggestion as to its improvement; I can only state that in the opinion of our ship-owners, it has materially deteriorated at the entrance to the port of Ipswich.

To what do you attribute this deterioration?—Of my own observation I do not know that I can give any very valuable information; but my impression is, that the great alteration has arisen from the removal of the cement-stone at different times, which has altered the current; but how it has had that effect I cannot say.

What has been the effect produced by that alteration?—The effect has been on the opposite side, Landguard Fort, the land has run out very considerably. I have a place at Felixstow, about two miles north-east of Landguard Fort, from which spot a great deal of cement has been taken; and since it was taken away, the sea has encroached and taken away a part of my garden: I can speak to it for 20 years; for the last few years they have

John Chevalier Cobbold, Esq.

6th June, 1844.

ceased to take away the stone, and the encroachment of the sea has not gone on to the same degree.

Have you adopted any steps for the security of the land?—I have not myself, I have not been possessor of the place till of late; I have had an offer from the contractor here who does the Ordnance work, to put out some groynes, which I have thought of doing.

You do not think that the mischief now going on requires more than the putting out those groynes?—I do not think of doing more than that; it is a very expensive work.

Is the water at Ipswich diminishing?—I think it is not; we are laying out a great deal of money in dredging; we have laid out 100,000*l.* in docks within the last four years.

What sized vessel goes up?—I should think at present about a 200 tons vessel; but we have constructed the docks with an entrance to accommodate vessels of 400 tons. We have, within three miles of Ipswich, from 15 to 16 feet at low-water, at a place called Durham Bridge, and are deepening the river from that place up to Ipswich, at high-water to 17 or 18 feet, to take up vessels of from to 300 or 400 tons.

What is the greatest number of vessels that you have known at Ipswich at one time?—We had last year entering at Ipswich, inwards, 1155 vessels, besides those vessels which came in ballast; outwards 855, but a very great many vessels go outwards in ballast because we have a large proportion of colliers; and I think belonging to the port there are 167 vessels: I think the average tonnage of the vessels of the port may be about 80 tons.

Are there any harbour dues?—There are tonnage dues, from which we received last year 1,496*l.* for the year ending the 8th January last, on vessels the tonnage dues varying and increasing gradually from 1*d.* a-ton for vessels under 50 tons, to 1*s.* 6*d.* a-ton for vessels of 300 tons and upwards; then we have, besides that, a duty of 1*s.* 6*d.* a-ton on coals, amounting to about 5,000*l.* a-year.

Can you suggest anything which should be done for the improvement of Harwich Harbour?—That is rather an engineering question; I presume that if the entrance could be narrowed so as to sharpen the current, that might have the effect of increasing the depth of water.

Is there anything you would wish to state yourself with respect to the depth of water?—Nothing, but to impress upon the Commission the extreme importance of this harbour to the port of Ipswich, which is an increasing port; and where we are laying out a great deal of money in improving the port itself.

In what way?—By our docks, and by deepening the river.

Have you any interest in the railroad?—Only as an inhabitant of Ipswich, and having an interest in the bank here.

Do you understand that the Company are willing to pay 30,000*l.* for the building a pier here?—I heard that stated in the Committee of the House of Commons, but I have not taken any part in that railway; I have been promoting another railway to Ipswich.

(*Capt. Washington.*) Is not the preservation of the entrance of Harwich Harbour essential to the port of Ipswich?—Certainly.

(*Chairman.*) How is the money you receive for harbour dues and for duty on coals expended?—About 5,000*l.* is paid as interest on the 100,000*l.* we borrowed to do the work, and the 1,500*l.* a-year beyond that defrays the expense of the dock and river, and management: the year's average of our income gives about 6,500*l.* a-year.

With such an income as that, the people of Ipswich are capable of taking care of themselves in improvements, are they not?—Yes, we take care of ourselves from a place called Levington Creek, the limits of our commission; but 5,000*l.* a-year of our income goes for interest on our expenditure already incurred.

[*The Witness withdrew.*]

Adjourned.

LONDON.

Monday, June 10th, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Lawrence Holker Potts, M.D., examined.

Lawrence Holker Potts, M.D.

10th June, 1844.

(*Chairman.*) Where do you reside?—At Blackheath.

What is your profession?—A physician and surgeon.

What is the object of the plan which you have to submit?—The formation of harbour breakwaters, of simple structure, principally by means of sinking tubes, more particularly applicable to foundations in sands.

Have you ever tried your plan practically on any part of the coast?—No, I have not; I applied to the Admiralty by memorial at the recommendation of Lord Haddington, and I received in answer that they had kindly transferred the matter into your hands.

How long is it since you first proposed this plan?—I have had similar matters under my consideration for the last five-and-twenty years or more, having accidentally been placed near the coast in Cornwall.

Lawrence Holker Potts, M.D.

10th June, 1844.

Have you ever showed your plan to any committee?—No, never.

Not before the Committee on Shipwrecks?—No, it is quite recently that I have turned my attention to this particular department.

Will you be good enough to enter into an explanation of your plan?—It having appeared to be a great desideratum to have a more ready means of forming foundations in sands and deep waters than any means hitherto afforded have given us, I contrived the means, which I shall have the pleasure of showing the Commissioners, of drawing tubes rather than forcing them into sands, mud, and other similar substances.

What do you mean by "drawing tubes"?—By taking off the pressure of the atmosphere from the interior of the tube, forming, in fact, that action which we well know by the name of suction; I draw a current of water and sand or other material through the tube; the ascending current of water carries with it this sand and other matters miscible with water; the ascent of these materials with the water displaces the substance or soil, unfooting, as it were, the pipe, which we would cause to descend; but really one moment's inspection of the working-model will render it much more clear than my description.

Are you not prepared with any written statement of your plan?—I have the specification of my patent, which was enrolled a few days since, but that is very long.

The Commissioners wish for a distinct account of your invention, making it as succinct as you can; will you be good enough to exhibit your plan by your model?—I shall be happy to do so. (*The Witness exhibited his plan by inserting a tube in the sand and extracting first the air and then the sand and water by means of the air-pump.*) The sand passes over into the receiver; this sand is used in forming the cement to unite fragments of rock into solid artificial rock. Having by means of a set of tubes, which in England we should make of cast-iron, formed parallel walls, we fill the interstices between them with fragments of rock from the cliff; these stones may be united together by means of a vessel with compartments, in which sand and shingle with roman-cement or lime, or other cement, which may be mixed together. We pass this into the sea-water under the surface and cause the compartments to open in succession: the contents are passed down dry, and by means of the sea-water they unite on the spot the fragments of rock, so as to form the whole of the interior into one solid artificial rock. Thus under water we have the power of forming a solid rock, which appears to be infinitely superior to concrete or other semi-plastic compounds, which are generally made use of; this is shingle and sand mixed with roman-cement; it forms a substance much harder than chalk (*the Witness produced samples*): this sticks to the vessel it is formed in so firmly that it is with difficulty we break it off. I have used different matters to form cements cheaper than roman-cement; I make use of these for the purpose of uniting the fragments of rock; it is solid in five minutes; in working under water with jointed or flexible tubes we have this advantage, that instead of an accidental leak drawing air we draw water, which percolates slowly, and does not derange the action of the pumps. I have been told by some persons that they have tried to get a steel-bar into the sand, but could not effect it to any considerable extent, while I effect it at once by this air-pump.

Suppose this to be carried on in a place like the Goodwin Sands in any exposed situation, could this apparatus be worked there conveniently?—Yes, in that case I should propose to put down a series of tubes, which may be fixed together with flanges, as the gentlemen engineers could do much better than I could; I merely claim the principle. By a succession of tubes we should get a footing.

You fix them in a sort of groove?—Yes, and having a degree of curve given to them collectively, we should oppose an arch to the action of the sea. In forming a break-water, for greater security, I should tie the tubes together, uniting them into one perfect body by lateral bolts, and thus extend it into the sea to any distance one perfect case of iron.

These tubes go down one by one?—Yes, in places where iron is not so cheap, we have the means by bolts of taking off three sides of each tube, leaving only the interior plate as a protection to the rock.

Is there any wood in any part of your structure?—No, but in places where we choose to make use of it we could pass down tubes or plates of wood prepared by Payne's or other processes.

Is that part of your plan?—I would leave all that detail to the engineers who take my principle and work upon it. This is an application of a principle which hitherto has been made nothing of. The idea must have struck others of pumping down tubes into quicksands, but until I introduced this recipient the pumps must have become choked; by this means we avoid all trouble of deranging the action of the pumps and get a ready mode of discharging the sand, &c. This method of sinking very large tubes is a result which I hardly imagined when I set about it instead of sinking large shafts or caissons with closed ends; I found the use of a smaller or operating tube effect my purpose readily: by this means I could get down very large tubes: it appears to be the very reverse of the plan on which Mr. Bush went; he forces air down, but I exhaust.

What do you call a large size?—Eight feet diameter or more; those being bolted together as with a kind of diaphragm occasionally across. This (*diagram* A.) shows the means by which I should propose, if it be the pleasure of the Government to set me to work on the Goodwin Sands, and I think I could get to the bottom of the sand. I suppose this (*the inner tube* B.) to be of sufficient diameter to be capable of permitting a man to descend; he carries an elastic hose with a trunk which he directs in the inside of the larger tube to be sunk, he applies it to the sand, and the current being formed, sucks up

the sand and water together, thus undermining the foundation of the latter, consequently it sinks.

Lawrence Holker Potts, M.D.

10th June, 1844.

He pumps it to the top?—Yes, if the distance be less than 30 feet; if more, I should apply the jointed tube or hose to the top, or have successive lifts, or make use of a diver with a diving helmet. From the same boat air is forced down to supply him, and the action of other pumps is kept up to extract the sand. Some eminent French engineers asked what can we do in the case of the "Télémaque?" I said, supposing the depth of the sea too great for other means, I should send down divers with helmets, who should be supplied with my operating tubes, which, being directed to the spot to be searched, would carry up the sand and water with great rapidity. We have tried our power at 28 feet above the surface of the sea; we should in fact, from a boat, have to make only an exhaustion of three or four feet, the sea-water being that depth from the edge of the boat. In sinking tubes into sand, the assistance given by the sea is considerable, for if your recipient be placed at low-water mark, you have at high tide about 20 feet above it to assist the upward current of the sand and water in your tubular piles.

I had a fancy that we should meet with sand so interminable that we should be obliged to unite the tubes so as to form a compact aggregate; therefore I formed a plan of forcing lime pastes or cements down by hydraulic pressure through the tubular piles, so as to unite them together, using short tubes alternately with the long ones, and thus form an aggregate by agglutinating the sand; but that does not appear necessary in most cases, for there are few sands in existence, as far as I can learn, in which we could not go down readily to the bottom.

At Dover there is not sand?—There is some, I think. By letting down a tube or machine with exhausted air you could ascertain the depth of the sand. The exhausted receiver being set in action, you might draw up the sand, and know the distance between that and the solid rock

You do not profess to act anywhere where there is not sand?—Yes, it is not of the same importance; but by means of tubes you would be able to carry out foundations with comparative ease in deep water to any distance that might be found necessary.

How are the tubes set on the rock?—By their being bolted together and tied with bars. Supposing we have carried out tubes with bolts between, and they were carried down to the rock; those tubes are let down by the exhausting principle, which gives the power of sinking tubes with readiness one after another, footing them through quicksand, shingle, &c., in the chalk.

Supposing there is no sand, as is the case at Dover, what should you do?—Then I should send down the tubes one after another and bolt them together.

Would they have any hold of the ground?—No, no deep hold, merely a footing in the chalk; they would stand by themselves and be like a wall, piece by piece, held together by lateral bolts, and transverse and diagonal ties or bars of iron securing, and secured by, the artificial rock which they enclose.

Your system would not be applicable to Dover?—I think, eminently so.

Supposing no sand to exist there, how would it be applicable;—I should pass down my tubes, beginning from the shore, and fill the space with chalk from the heights above, a succession of masses of tubes, and fix them as fast as I could get on, thereby I should carry out my artificial rock to any extent.

What is there new in that?—Possibly there is nothing new in it; but I do not know that tubes have ever been used for such purposes before, and in such a manner.

Suppose this to be the shore at Dover, you take different lengths of trunks?—Yes, and make an iron wall there; I fill up with large stones united with cement, so as to form a perfectly satisfactory rock, and if the game is worth the candle, you may, with the shingle, make a rock harder than any rock we have in that part of the country.

Suppose you had to commence in deep water?—There would be a difficulty in beginning in six fathom water; I should prefer carrying on the work from the shore; but that may be done, though not so easily.

Your printed paper speaks particularly of the Goodwin Sands and other sands?—Yes.

Suppose you inserted these in the Goodwin Sands, would not the action of the tide and waves carry away the sand from about your piles which are thus opposed to them?—Yes. I have provided for this contingency, by affording facilities for the insertion of fresh piles, but it might be an object to have the sea wash away the sand; we can always continue our bulwarks so as to leave it in steps, or conveniently approachable by boats or larger vessels.

Then there would be a great depth of water outside, perhaps six, seven, or eight fathoms?—Yes; we can withdraw the tubes when they become useless in the interior, and carry on a succession to any distance which may be thought desirable; but the difficulty I have anticipated is in getting through the hard sand (*The Witness showed the operation of the air-pump in extracting the sand*). This shows the way in which the tube is sunk into the sand; it also shows that after the tube is emptied of sand and water, it remains empty for a length of time, only filling by slow filtration, so that a man can descend and work the small or operating tube in the large tube without any inconvenience from the flow of the water within. The deeper we are in water, of course the greater the filtration; but it is supposed the Goodwin Sands are of very firm texture in the centre.

You suggest the idea without explaining the practical operation?—I am not conversant with the terms and technicalities of engineering but from the opinion of those

Lawrence Holker Potts, M.D.

10th June, 1844.

practical men who have seen my inventions, I have no doubt but professional engineers would be able to carry them out much better than I could.

Are there any engineers who have inspected it and expressed their approval?—Yes, several eminent ones; amongst others, Mr. Alexander Gordon and Mr. Brunel.

Would Mr. Brunel join with you in the experiment?—I do not know; I have not as yet asked him.

When you speak of those gentlemen having seen your plans, the question is to what event they approve of them?—That I cannot say altogether.

You feel no doubt of being able to carry down a line of these tubes, eight feet in diameter, of which the bottom should be made to reach the rock below the Goodwin Sands?—Yes.

It is proposed to sink to the chalk by means of the exhausting principle?—Yes; my crude idea was to put on the Goodwin Sands a kind of T which would afford a protection to vessels in all winds; I have been on the Sand, and it appears to me that by means of penetrating the Sands, I should be able to keep my tubular piles perfectly vertical.

Have you seen the sea on the Goodwin Sands in a gale?—Yes; there I should leave the tubes as a breakwater, so high as to show above highest tides.

(*Lt.-Col. Alderson.*) You propose to send those cast-iron piles down to the rocks, affording an opportunity for having on the top a lighthouse or battery, or whatever might be required?—Yes.

Is there anything else you wish to explain by your model?—No; not by this model.

Your object in proposing this plan is merely that if the Government approve of it, they should take it in hand and execute it themselves?—Exactly so.

You do not propose on your own responsibility to undertake any expense?—Not unless I am requested to do so.

To give it to the Government, to let their own engineers work it out?—Yes.

You have a patent for it?—Yes.

You propose to give it to the Government for a compensation?—I have no fear on that head but that I shall be handsomely dealt with.

Mr. Walker.—I do not think that it is necessary to trouble Dr. Potts by asking any question further, but I should wish in his hearing to state what I understand to be his principle, that if he can further explain it he may have an opportunity of doing so. His principle is to sink a pipe or pile, or other foundation, down through the quicksand to the rock, or to a depth that any erection may be placed upon it; and that he does by applying to the inside of the tube a pump, which draws the water and the quicksand from the bottom. The way in which that, according to the present mode, is done, is by means of dredging or what is called misering, which is by means of a scoop or bucket attached to a pole, or otherwise, drawing up the sand, and allowing the pressure at the top of the vessel or pile to sink it; but the manner in which he proposes to sink the pile or vessel, by means of exhausting the sand within it, and the mode of exhausting it, is to me perfectly new. I have never seen it before, and I confess that the tube descending, as it appeared to do, somewhat surprised me; it was a result I did not expect, I admit: there is ingenuity attending it,—how far practically it may be applicable is another thing; but I cannot help saying that, as far as I can judge, the invention of Dr. Potts has a great deal of ingenuity attaching to it. This principle of exhausting would not be applicable, I take it, to cases where there is rock only; it must be sand over the rock: and even if it were shingle, or anything but sand, I do not think that part of his principle would be applicable.

Dr. Potts.—I am obliged to Mr. Walker for his opinion. I wish the Commissioners to have the kindness to see the apparatus working in my place; they will be astonished to see the power of it, even in removing shingle so as to form a foundation; till they see it they can form no conception of its capabilities. I contrived the means of turning the larger tube round, and made it saw-like at the lower edge: thus, as it were, trephining or trepanning the rock, I got a firm hold, and rendered it water-tight; but it appears to me that in most cases this is useless labour,—that as soon as the pile is fairly down to the bottom, and bolted to the tubes at its side, and to those opposite, it would do without the necessity of trephining it into the chalk; but matters of this kind are so obvious to a man who is possessed of the principle, that I do not think it is necessary to detain the Commissioners with the detail; I shall be happy to show it them at my house, No. 9, Buckingham-street, in the Strand, which is in the immediate vicinity.

Have you any printed statement of your principle?—No, only a little thing I drew up, and which I perhaps circulated a little too freely.

Without some statement or diagrams, to give your view of it, persons not conversant with this matter can never sufficiently understand it?—I should rather the Commissioners exercised an unbiassed judgment upon their view of the experiments and models than on anything I could say.

Will you furnish a written statement of your plan, with diagrams explaining it?—I shall do so with pleasure.

[*The Witness withdrew.*]

Commander *William Crispin*, R.N., examined.

Commander *William Crispin*, R.N.

10th June, 1844.

(*Chairman.*) Were you on the Portland station for any time?—Yes.

In what service?—I was first of all stationed there in a revenue cutter, the "Swallow."

How long were you there?—I was for two years on that occasion constantly on that station, and I have been in the habit of frequenting it during the last seven years, while in command of the "Vulcan" revenue steamer.

Have you been in the habit of passing in and out between Portland and the Shambles in the night?—Yes, at all times.

If you were coming in from sea with a large ship in a heavy south-west gale, would you come within the Bill of Portland and the Shambles, or go to the eastward of the Shambles?—I should, with flood-tide, come inside the Race, between the Race and the Bill, and between the Shambles and the Bill.

In heavy weather?—Yes.

In a large ship?—Yes.

You would not go to the eastward under any circumstances?—No, unless with ebb-tide, I should not, knowing it so well as I do.

What is the common practice of pilots, do they go between the Shambles and the Bill, or to the eastward, in the night time?—I cannot say positively what their practice is; but if the wind was at all from the westward, they would have to beat up, and could not get into Portland Roads so well by going to the east.

The Commissioners find generally among the people of Weymouth that they go to the eastward of the Shambles?—They may do so; but the Channel pilots know little of the Race as compared with what we employed in the Revenue Service do, who are in and out by day and night so constantly. I never, in the "Swallow," attempted to go outside the Race; I always steered right for the Bill, and was sure to get round.

Do you think that a vessel going to the eastward of the Shambles would do it without a light at the end of the Shambles or a cross light?—I have been at the east end of the Shambles frequently, but could never tell exactly when I was round them; you can only judge of your distance by the lights and bearings.

Have you ever had much thought about a breakwater?—Yes, a good deal.

What is your opinion as to the line it should take, and the distance it should go out, and what its bearings should be?—My idea of Portland Roads as an anchorage for vessels wind-bound is, that it is so good that it does not require a breakwater at all.

You are opposed to a breakwater there altogether?—I think so, the anchorage is so very good.

Do you think that it would be a safe anchorage for a convoy of 50 or 100 ships, with an easterly gale of wind?—Not for so great a number as 100 ships to lie there.

What you speak of is for one or two vessels?—No; I should say 30 vessels could with safety. I never knew a vessel drive with an easterly gale of wind when in a proper berth.

You consider a breakwater there unnecessary?—I think so.

Is there not a great deal of sea tumbling in there with an east wind?—Not if you anchor in the proper position.

With a fleet of 50 sail?—I should think in a fleet of 50 sail some would do so, and find much sea.

Is there not a great deal of sea coming into the anchorage with an easterly gale?—With an anchorage for 50 sail of ships, the outside ships would certainly experience a great deal of sea.

Would not a breakwater give them protection from that sea?—If run out to a sufficient distance from the island.

How far would it require to run out?—I cannot say with certainty.

The Commissioners understood that you had something particular to state with respect to Portland, they were therefore anxious to see you; if you have any information to give they will be happy to hear it?—I was not aware of that. My knowledge extends along the whole line of the coast, as I have been for the last seven years employed in the "Vulcan" for the protection of the revenue, and my cruising-ground extended from Bristol round the Land's End to the Thames.

What do you know about Beachy Head?—I have often anchored there.

On which side is the best anchorage?—On the western side.

Off Seaford Head?—Under there.

Do you know much of the eastern side of Beachy Head?—Yes; I have anchored there, at Eastbourne, and all along the coast, my duty having required me to anchor in those spots to send away my boats for the protection of the revenue.

What sort of ground is there in front of Eastbourne?—I cannot say exactly what kind of ground it is.

Is it a rocky bottom?—From anchoring every night on different parts of the coast, I cannot take upon myself to say exactly the different sorts of ground in different parts, but I never found any inconvenience in anchoring off Eastbourne from a rocky bottom.

You are aware of the Royal Sovereign Shoal?—Yes.

And other shoals along that coast?—Yes.

Commander *William Crispin*, R.N.

10th June, 1844.

Is there not a great deal of foul ground between the Royal Sovereign Shoal and the Eastbourne Shoal?—Yes.

Supposing, as a seaman, you were called on to state on which side of Beachy Head you would make a harbour, on which side should you say?—The western side decidedly.

For what reason?—Because I think the ground is better there, and you can come nearer the shore.

Suppose a breakwater off Eastbourne, at the distance of a mile and a half or two miles, boats could never communicate with the shore in easterly gales, could they, with the surf on the shore?—I should say not.

Consequently if they had a breakwater two miles off they must have a harbour within for small vessels?—Yes.

Having a breakwater off Seaford, they would have Newhaven open?—Yes.

(*Admiral Dundas.*) Suppose, in case of a war, it were felt to be necessary to have a port where steamers could go in at all times of tide, wind, and weather, and to have a port of refuge for merchant-vessels, where would you recommend such a harbour between the North Foreland and Beachy Head?—I should say Beachy Head would be the most eligible spot along the whole coast for a harbour of refuge.

Suppose you had a harbour of refuge at Beachy Head, which would be the second to the eastward?—Dungeness; I say Dungeness, because I think a merchant-vessel would always get from one point to the other in one tide.

Why should you prefer Dungeness to Dover?—Because you could always approach it at all times of tide.

The question refers to a breakwater like that at Plymouth. Where would you select a spot, between Portsmouth and the North Foreland, where a harbour on a large scale could be made?—I should say Beachy Head in the first instance, then Dungeness; I think that vessels coming up Channel are clear of all danger as far as Dungeness, that is one reason why I would place the harbour there; secondly, if a vessel runs up as far as Dover she would naturally run on for refuge into the Downs?

Suppose you combine that harbour of refuge with a position for steamers to go in and out at all times of the tide?—One place would be nearly as good as the other for that purpose.

Could a steamer go in any weather from Dover to Dungeness?—Yes; she ought to have power sufficient.

Would you think it an advantage to have a port such as has been described at Dover where there was an inner harbour, and where vessels could be repaired?—The great point must be its accessibility during all times of tide; with a steamer, that is every thing.

Will you refer to that plan (*the plan of Mr. Cubitt for Dover Harbour*), do you consider that a harbour such as this is better placed off Dover, where there is an inner harbour for vessels to repair than if built at Dungeness where there is no accommodation of that kind, particularly as you have stated that a steamer can always get up in any weather from the Downs to Dungeness?—I would prefer Dungeness, taking all things and circumstances into consideration connected with the maritime interests of this nation.

You are supposing them to tide down Channel always?—I think that in the coasting trade they generally do so; vessels leaving the Downs would reach Dungenees very well; whereas, getting into this refuge harbour off Dover would be no distance.

If you wanted a place for the protection of the Downs for a squadron of steamers, what position would you take for a harbour?—Dover, certainly, for the protection of the Downs.

For the merchant-service you think Dungeness the most eligible?—Being obliged to place a harbour between Beachy Head and the Foreland, I say that Dungeness is the most eligible for the merchant-service.

Which should you prefer for the war-steamers?—They would lie as well in the Downs as anywhere else.

Combining the two together, the men-of-war and the merchant-service, which of those two would you have, supposing only one to be provided?—For a man-of-war station, Dover would be the best; but taking the two points into consideration together; if there were only one, I should say Dungeness, as it is only an hour and a half's steaming, after all, between Dungeness and Dover for war-steamers.

Suppose a breakwater to be erected in the East Bay at Dungeness, as it must be outside of the Swallow Bank, could boats communicate with the shore in an easterly wind without further protection inside?—I should think they might; but I have never anchored there in an easterly gale, therefore I cannot say positively.

Could an army embark there with an easterly wind?—Yes; if you could take the ships round the Ness point, as I have been lying on the west side of Dungeness when it has been blowing hard from the eastward, and I did not find much sea on the beach.

If you were at night to the eastward of Beachy Head, and a storm with rain came on, and you had it in your power to have an anchorage, and a breakwater to the westward and another to the eastward with a strong south-west gale, for which should you run, on the weather-shore or the lee-shore?—That would depend on the formation of the breakwater, but if I could obtain shelter in one or the other, I would rather go to the harbour to the westward of Beachy Head.

Commander *William Crispin*, R.N.

10th June, 1844.

In running into Portland Roads, ships very often go outside the Race and inside the Shambles?—Yes; there is a very good passage.

That is the general passage of all ships, is it not?—No; I think that they go outside the Race: men not very well acquainted with it, go outside both.

(*Sir B. Martin.*) In case of a war, and that we were obliged to have a squadron off Portland to watch the Channel, would it not be necessary to have a breakwater?—Yes; in that case it would be most desirable.

And for the collection of convoys?—Yes; as regards communication also; if you wish to make Portland a harbour of refuge, it would be very much better with a breakwater than without one.

Is not that in contradiction to your former evidence?—I did not consider the former question to refer to a harbour of refuge, but merely as a roadstead. I have always been used to speak of a breakwater at Portland with reference to it as an anchorage to bring up and afford protection to ships wind-bound. I beg to be allowed to correct my answer if it is put to me, whether, as a harbour of refuge, a breakwater is not wanted in war, where steamers could coal and vessels could be protected, I should say decidedly place a breakwater at Portland. I have always anchored, the Portland point bearing south-south-east.

In what water does that point bear S.S.E.?—Five and a half fathoms.

What room is there in that spot for vessels to lie?—They can lie from the Castle, where they load the stone, along to the point of the slide.

Supposing a breakwater run from Portland and followed into the Bay, would that be sufficient to protect a fleet of merchant-men in a foul wind, and also steamers so as to obtain for them the facilities of coaling and so on?—No; I would rather extend it further out.

If it was a mile and a half, would you have a passage between Portland and the breakwater for vessels to run out, or would you join it on to Portland?—To make it complete, I would have a passage between the breakwater and the land, for they would find it difficult sometimes to beat round the north end when the wind chops to the northward and eastward very suddenly.

Would you have an opening between the land and the breakwater, or would you have it in the middle of the breakwater?—I would have the opening between the land and the breakwater, not in the middle; for this reason, they could haul round very close to the shore the instant you got past that point called the Slide.

Suppose they were going to the south, they might weather round the land from the opening in the middle?—I would rather go outside in that case.

Is there not a danger from hugging that shore too close, from the gusts of wind that come off?—No doubt it is very squally, and you would certainly get the gusts more suddenly close in shore; but I never saw any accident in consequence of those squalls.

How far off do you meet with those gusts?—You get them a mile off, but not so violent as close in with the shore.

(*Sir H. Douglas.*) Where would you put your southern entrance, into the harbour close to the shore, or would you build a pier into three fathoms water, and then make an opening into five fathoms?—This short pier into three fathoms water would be very easily built, and would be a great safeguard to vessels running through the opening.

You would place your breakwater in Weymouth Roads, as it is placed in Plymouth Sound, a detached breakwater?—Yes; with the exception of the short pier running from the island into three fathoms water.

The first question that was asked you was, if it were considered necessary that a harbour of refuge should be provided in the Channel between the North Foreland and the Isle of Wight, where would you place it?—I should say, Beachy Head.

That is supposing there were only to be one?—Yes.

You know the Downs?—Yes.

You know the Ness and Beachy Head, and you say that there is very good anchorages at each for merchant-vessels when the wind becomes foul?—Yes.

But you say, if one harbour of refuge were made, you would place it off Beachy Head?—Yes.

Those places are very good anchorages; but in the event of a war, it will be necessary to make a further provision, where men-of-war can be laid along with the merchant-vessels to protect them—men-of-war and steamers, where they can coal and water—would you then prefer making that harbour of refuge at Beachy Head in preference to the Downs?—If there was only to be one, I should prefer Beachy Head, as the most central point, and most clear of dangers for vessels to approach.

Considering that all the vessels that come down the river take refuge from the south-west winds, would you prefer to come further that way to Beachy Head rather than make some little alteration in the Downs, so as to convert that into a harbour of refuge?—I go upon the principle that there would be no harbour of refuge between the Downs and the Isle of Wight; vessels can always anchor in the Downs for shelter.

But there is no harbour of refuge there?—No; but we always look upon it as capital good anchorage now, and that we are generally safe there.

You are not safe against an enemy there?—No, unless you had protection stationed there.

Supposing a harbour of refuge were provided in which men-of-war, and men-of

Commander *William Crispin*, R.N.

10th June, 1844.

war steamers can lie and protect the vessels?—I have given the thing a good deal of study while I commanded a steamer; and I think it would be necessary in case of war to have a sort of block-ship, with guns mounted, on many parts of the coast; and between which and the shore I would make all merchant-vessels anchor.

Admitting that you could protect vessels in the Downs, would you consider it necessary under those circumstances to erect a breakwater two miles off Dover, so as to take in a large fleet of merchant-men that have to be protected by men-of-war steamers and line-of-battle ships, and so on?—No, I should not.

Supposing a breakwater made from Sanddown Castle over to the Brake, there would be a very large space, supposing the same sort of breakwater made off Dover, should you prefer that to the space within a breakwater off the Downs?—One would be as good as the other; but as regards the harbour off Dover, were I placed in a situation to have it said to me, you will form a harbour of refuge between Beachy Head and the North Foreland, and you will protect the trade of your country also, I should say, place block-ships in the Downs, and make all merchant-vessels anchoring there anchor between them and the shore; I would then place the harbour of refuge at Dungeness.

(*Lt.-Col. Colquhoun.*) You are aware that block-ships may be burnt?—Yes, certainly.

(*Capt. Fisher.*) It appears that your answers to the former questions, where in your opinion an asylum harbour should be constructed, have been principally in reference to ships homeward bound; where in your opinion would be the best place to construct an asylum harbour capable of receiving men-of-war, armed steam-boats, merchant-ships of the largest class, and the trade generally, both outward and homeward bound, accessible at all times of the tide, from the mouth of the Thames to Portsmouth?—Beachy Head.

Where should you say for a second?—Dungeness.

Are you aware of any objection to such a harbour being constructed off Dover?—No, I am not aware of any objection; but I say Dungeness, from its better position, in my opinion.

Could a fleet of merchant-ships always sail from and proceed down Channel from a harbour constructed off Dungeness, with the same wind, and under the same circumstances that they might do from a harbour constructed in Dover Roads?—Yes, I should imagine so.

Are you aware how the extreme point of Dungeness will bear from a harbour constructed off Dungeness?—No; I am not aware exactly of the point of compass, as I do not know how far the breakwater would be carried out, neither could I say in the same way as to Dover.

Are you aware of the course that will carry ships clear from Dover Roads?—Yes; if they steer W.S.W., it will carry them clear.

Are you of opinion that merchant-ships unacquainted with Portland Roads, and seeking shelter there in heavy gales from the westward, will go in to the eastward or the westward of the Shambles?—Under these circumstances they would go in to the eastward of the Shambles.

Are you of opinion that for such ships and vessels a floating light on the Shambles would be necessary as a direction for reaching the anchorage of a refuge harbour?—It would be of very great use indeed, both as a harbour of refuge and roadstead.

(*Sir W. Symonds.*) In reference to a former question, as to the necessity of an inner Channel in the harbour of which you have seen a plan, could or could not vessels sail through that inner passage, and make their voyage down Channel in such weather when they might not be able to fetch out round the passage to the north of the breakwater; for instance, in a wind east or east-north-west?—Yes, under peculiar circumstances.

Are you of opinion that if a harbour of refuge was constructed in Dover Roads, such as has been described for men-of-war steamers, as well as merchant-ships of the largest dimensions, that would or would not be a situation to give protection both to vessels to anchor in the Downs and also in Dungeness?—To a certain extent.

Putting steam-vessels out of the question, would you recommend a pier-harbour to be made for merchant-vessels and men-of-war in a situation like Dover on a very large scale of a very expensive nature, where the holding-ground is not generally good over the space, and where there is said to be a tide of four knots during springs, running across the southern entrance, would a heavily-laden and weakly-manned vessel attempt to get into such a port with the Downs under her lee under all circumstances?—Were I placed in command of a vessel under those circumstances, I would decidedly prefer running into the Downs.

Are not vessels in thick weather cautious with regard to approaching the larger bay between Beachy and Dungeness, on account of the Royal Sovereign Shoal, the Horse of Willingdon, and the foul ground generally reported to exist there?—Yes.

Do you consider that convoys or straggling merchant-men seeking a port of refuge would venture between the Race of Portland and the Shambles of Portland, not being used to the navigation?—A man could go between the Shambles and the Race of Portland; but I do not think he would come between, as most men not thoroughly acquainted have such a horror of the Race.

Would not the wind be baffling on the high land at Dover for all merchant-vessels comparing it with Dungeness?—Yes; but I never found the wind to be very baffling off Dover.

Commander *William Crispin*, R.N.

10th June, 1844.

Might not vessels bound to the eastward fetch round the South Foreland from Dungeness, when they could not fetch out of the harbour in question off Dover, being in a degree embayed?—One vessel anchored at Dungeness bound to the River Thames, and another off Dover, under similar circumstances; the one in Dover would, I should think, certainly get round the South Foreland before the one from Dungeness.

Supposing a vessel to sail from Dungeness, could not she get into the Downs when a vessel lying in the harbour would not be able to accomplish it?—I understood the question to allude to their both starting at the same time; it is matter of opinion, I think; I cannot take upon myself to say which.

Do not vessels generally consider it necessary to get under weigh when the wind shifts to the eastward of south, as Portland at present exists?—Most vessels that anchor in Portland Roads now are there for shelter from westerly wind; therefore, as soon as the wind gets to the eastward of south, they get under weigh to go down Channel; but vessels lying there for cargoes of stone remain in Portland Roads from whatever quarter the wind comes.

Speaking of the southern or inner passage into the breakwater at Portland, would it not, if of any considerable width, expose the best parts of Portland Roads to the sea, the parts where small vessels generally lie at present?—No; I should think the width in the breakwater would not be of sufficient distance to admit the sea to come home through it: it is astonishing to see how little sea there is close in shore, even now with the wind right in.

(*Chairman.*) Have you ever known any vessels driven on shore in Portland with an easterly wind?—Yes; from their ground-tackle being carried away. I never knew them drive on shore.

Supposing you commanded a squadron of steam-vessels in the Channel in time of war for the protection of the shipping, would you station any of them at Dover, supposing you had facilities for stationing them, and could station them where you pleased?—Taking everything into consideration, it would be more advisable to have steamers off Dover than it would be at Dungeness. Had I the command of a squadron of steamers, I should be guided to a very great extent by the information I might receive, and many other circumstances combined; as regards Dover or the Downs, or Dungeness, it would be a matter for consideration, under the peculiar circumstances, which of those three places I stationed myself.

Do you consider the Downs so conveniently situate with reference to the opposite ports as Dover?—Yes; very nearly so.

Suppose the force sufficiently large to distribute?—Then I should certainly place some of them there.

Looking at the great anchorages of the Downs and Dungeness where ships anchor constantly in great numbers in stress of weather, what position, as commander of a fleet of steamers, would you take for the best protection of those anchorages looking to both of them?—I must be guided to a great extent by the wind at the time. If I am bound to take up one position, if the anchorage was good, viz., off-shore wind, near about Dover or Folkestone I would be there; but if I had a sufficient force under my orders, I would of course have some steamers at each place.

You stated your preference for Beachy Head, as affording shelter for merchant-ships in the event of a war, would one harbour be sufficient?—No.

Where would you place the second?—At Dungeness.

Are you guided at all by the wish to have a harbour of refuge to the west of Beachy Head by its proximity to Newhaven?—Yes, to a certain extent.

Do not you think that it is much better to have a harbour near a small place, where you might get your supplies of coals and so on?—Yes, taking that into consideration, it is an additional reason why I would place the harbour at the west side of Beachy Head.

You consider that Newhaven, as an auxiliary harbour, would be important?—Yes.

On the same principle, do not you think that Dover Harbour might be of great advantage, by enabling a fleet to obtain any repairs which might be required, and also a supply of provisions and coals, considering that that port is already fortified, which Dungeness is not; that it is a place where you could embark an army at a few hours' notice, and that it is in immediate proximity to a railway; under all these circumstances, which do you prefer, Dungeness or Dover?—Taking into consideration every circumstance, both as regards warfare and mercantile interest with which I am acquainted, I should prefer Dungeness.

[*The Witness withdrew.*]

Adjourned till to-morrow at 12 o'clock.

Tuesday, June 11th, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *James Bremner* and Mr. *David Bremner,* examined.

Mr. *James Bremner* and Mr. *David Bremner.*

11th June, 1844.

(To Mr. *James Bremner.*) You have a plan for constructing a breakwater upon a new principle, for which you have secured a patent?—I have.

Have you a description or specification of the plan?—Yes (*producing the same*).—(Mr. *David Bremner.*) This is a description of the machine itself.

The same was read:—

"*Description of Bremner's Patent for erecting Harbour Walls in Deep Water and under the most difficult circumstances.*

"The patent vessel, as shown, drawing No. 3, is 400 feet long, 100 feet broad, at bottom, 104 feet aloft, and 45 feet deep. When the building is complete for the deepest part of the proposed harbour at Dover, of the above length, 40 feet high, and 15¼ feet in thickness, each section will be 17,400 tons in weight, and float on 16 feet 6 inches depth of water.

"A. Is the stem and apron piece.

"B. Is the dead wood.

"C. Is the bottom part.

"D. Are frame timbers, all of American oak, white elm 10 inches abroad, moulded 10 inches at bottom and 4 at top, fastened to the floors with a plate of best scrap iron to go under floors and reach 3 feet up* on each side of frame timbers, the foot of each of which is to be tenoned into floor ends, and to be securely fastened in planking, which is to proceed on outside and inside at once; two screw bolts of iron, inch in diameter, to go through each timber at each tier of planks, and tightly screwed home with nuts on the inside planks.

"E. Are diagonal braces of 4 inch hard-wood plank, neatly nitched into and driven hard between the timbers, and secured by ¾-inch bolts, driven through each tier of planks, and well screwed home, throughout the whole.

"F. Shows the strakes of planking, which is to be of American elm and red pine of great lengths, 4 inches in thickness, and the mode of securing their butts, which are to scarf on at least 2 feet; the shiftings to be particularly attended to; no butts to be nearer than 12 feet to each other.

"G. The binding strakes, and also stringers, to be 18 by 6 inches, securely bolted with iron screw bolts through all the timbers.

"H. Are the stanchions.

"I. Are the rails.

"K. Is the bow, where 14 feet of space is to be left, and about 10 feet under the upper deck for a patent windlass, for working the chains and anchors from a lower deck, forming a forecastle.

"L. Is the open space where the wall of harbour is to be built of the requisite dimensions thence deposited in the place appointed.

"M. Are the deck beams completely crossing vessel, 2 feet 8 inches deep at centre compartment, 8 inches thick, to which the chains for suspending walls are attached in a tripping manner, but very securely; the beams are securely bolted and dowelled to stringers.

"O. Is a section of inside wall, as built on slip-bottom, and within vessel.

"P. Are cross beams to be secured by iron knees to the sides.

"Q. Are diagonal timbers for bracing down bottom, being securely dowelled or cogged into the cross beams, and nitched into the king-post, then securely bolted through it, cross beams and floors, which keeps the patent vessel firmly in shape, while the very great weight of wall, and pressure of water, are upon it.

"R. Are the diagonal timbers crossing beams, and diagonal timbers Q, to which they are securely bolted and dowelled.

"S. Are the beams formerly described.

"T. The king-posts which support the centre of the beams, by means of which the three compartments of patent vessel are securely bound together.

"U. Are railroads supported from the beams; small portable cranes are worked upon rails from both ends of the patent vessel, and can be projected 30 feet over the ends to take in any stones required.

"V. Are the chains formerly alluded to, hooked into screw bolts, between which plates of iron, into which they are screwed, are let into the wood.

"W. Is the stern and planking of same.

"X. Are cross beams to be sufficiently dowelled into hard-wood planks, and six iron screw bolts 1⅛-inch diameter screwed from inside, and kept in their position, until the passage from place of building to harbour is made, when the bolts will be unscrewed, and beams wedged off; the vessel is then hauled too, stern on as already described. The sections of walls to be bonded as shown, drawing No. 2, by using a mould during the progress of the work, when everything will fit together; bond being left, and a mould of it kept to fit the next section to, so that there can be no difficulty in making as good work as can be done on shore.

"The bolts are then all unscrewed out of the ends of sleepers, and only left in the plank to keep tight. The water is then let in by screwed sluices; and how soon the slip-bottom is fair upon the foundation, at low water, the sluices are shut; the tripping stoppers which hold the chains are all let go; when the vessel is immediately released, towed off, and as soon as the masonry is ready would do the same again.

"Two rudders will be necessary, one at each quarter.

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* Also an iron knee.

Mr. *James Bremner* and Mr. *David Bremner*.

11th June, 1844.

" Sails could easily be set to assist the steam power in propelling the patent vessel from the place near the quarry to the site of proposed harbour.

" The slip bottom may be made of plate iron.

" *Estimate of the Expense of Building one of Bremner's Patent Vessels of the dimensions herein described.*

	£.	*s.*	*d.*
113,071 cubic feet timber, at 1*s.* 6*d.*	8,480	6	6
359,100 lbs. iron work, at 2½*d.*	3,740	12	6
Workmanship, &c., say	2,000	0	0
	£14,220	19	0

Slip-bottom.

	£.	*s.*	*d.*			
5,946 cube feet timber, at 1*s.* 6*d.*	445	19	0			
2,240 lbs. iron work, at 2½*d.*	23	6	8			
Workmanship, say	28	0	0			
				497	5	8
				£14,718	4	8

" If used in building for six years the materials would then be worth one-half cost.

" Leaves to the debit of the work done about 7,100*l.* on each patent vessel, four of which are proposed to be used.

" *May* 25, 1844."

(*Chairman.*) Is the vessel to be kept in work during the operation?—(Mr. *J. Bremner.*) Yes.

What does the section you produce represent?—14 feet and a half of length.

Have you put this into practice?—Never, any further than lifting vessels. I lifted last September a vessel, with 500 tons of coal in her, sunk two feet in the beach or sand in Broad Bay, an exposed place in the Highlands of Scotland close to the Butt of Lewis, in 13 fathoms water. I raised her by these means.

What was there at low water?—There was 12 feet left of tide.

How does that illustrate your patent?—It shows the strength of what the beams could do. I had only two baulks of timber across each two ships, and lifted about 1100 tons; they were 14 inches baulk; the vessel was full of sand; the people gave her out as weighing 900 tons, but there was considerably more than that, with the vessel and the coals, and the sand, also the chains used in lifting her.

How many thousand tons do you propose to take in your vessel of 400 feet?—17,400 tons.

What is the breadth of vessel?—100 feet.

What is the depth or perpendicular measurement from the top to the bottom?—45 feet.

This is the shape of the masonry you put in (*on the section*)?—It is.

How do you contrive to keep the vessel upright?—We can balance the thing to a nicety.

Do you mean that there is an equal weight on each side?—Yes, as near as can be. I was a little hurried in making the model, it is to one side somewhat.

How do you counteract that?—We can easily make the one compartment larger than the other.

What water do you suppose she will draw during her voyage?—16 feet and a half.

Your object appears to be to construct your machine at the place where the best stone can be had?—Yes.

And then to have it towed by a steam vessel to the place where it is to be sunk in forming a harbour or a breakwater?—Yes.

Your vessel is, in fact, a caisson, only larger and of a different shape from those commonly used?—Yes, but it is different in many respects; there has been nothing of this kind ever used.

State in what respects it differs from a caisson?—The mode of construction, compartments, and slip bottom in particular.

What is the width or thickness of your proposed cargo at bottom?—25 feet.

What is the thickness at top?—Six feet.

What is the perpendicular height of wall?—40 feet.

What is the slope?—About eight inches to the foot.

Have you ever calculated the displacement by your vessel, so as to be able to make it clear, that she will have sufficient buoyancy for such a cargo?—I have.

When the vessel is in the position for sinking you have some contrivance to let in the water, or as we term it a scuttle, what is that?—By means of sluices to be opened by means of screws.

What do you allow for the weight of the stone?—14 cubic feet to the ton.

What will be the draught when the whole of the masonry is in?—16 feet and a half.

You cannot bring the vessel into a less depth of water than that for sinking the stone?—No.

Then how is the pier within to be completed?—We should build *out* from the shore.

Mr. *James Bremner* and Mr. *David Bremner*.

11th June, 1844.

In what depth of water could you feel confident of sinking your stone with accuracy?—It would be impossible for me to say, but by increasing breadth and height of the vessel we can go as far as from 7 to 10 fathoms.

Supposing one section of the stone to be placed, and you deposit the next section in continuance, can that be done with such nicety as to form the compact masonry you have exhibited?—I am convinced I can do it quite easily.

In what manner?—By making the timber moulds to fit; taking the timber mould and applying that to the section in the after part of the vessel where it was building, then placing two strong rods of iron perpendicularly fixed to the extreme end of section last laid, and stayed with diagonals on its top. Two strong bars of iron forked and with rollers at ends, to run upon the rods described to be fixed at the inner joining of section to be laid. The vessel being moored as shown on accompanying plan, the forked bars are brought exactly upon the rods in which the rollers move in sinking; the joining may thus be made very exactly.

When sinking a section in a depth of seven or eight fathoms, will it be sure to find its true position?—Yes; we take it stern on to the old wall, and as soon as the two come abreast of one another we have a powerful screw to heave them in close, and join them; this is done while it is afloat. We keep it in its position, which there is no difficulty in doing in a calm day, till it comes abreast of the old building; and as soon as the two come abreast of one another, we have several persons on the top to heave them close in; then we fasten them together, and then we open the sluices and let the water in.

Supposing the first section to be right, will the one find its place exactly on the top of the other course?—The lower longitudinal section will show that. I have shown that pretty clearly upon this. This is a map of the soundings at Dover. We begin in this kind of way; the courses all come up, and keep them level.

Are you now describing the ground section?—Yes. Where the greatest declivity is it shelves off in 500 feet from 11 feet to 46 feet at the western pier. The whole may be bound in one solid body.

How many vessels would you have?—Four.

Which would be the cheapest thing—to bring the stone to Dover, which you have selected as your instance, and there construct your masonry, or to construct it 200 miles off, and bring it round?—It depends altogether upon the locality where the stone is. If there is a good quiet harbour where the vessel could be built, I would prefer building it there, and towing it round.

Supposing, with a great strain upon a vessel of that kind, she became leaky?—It is all inside caulking; it is impossible she can become leaky. I will explain what I have done with small six-inch beams laid across vessels with 10 feet sand in the hold. I have taken six-inch spars, and put planks upon them, and some sleepers six inches thick on stranded vessels. And after getting them afloat I have been caught with heavy gales of wind, and rode it out in the Pentland Frith, and many other parts of that coast equally exposed, and brought them into safety without the assistance of steamers, of which we have none.

Can you be secure against the plank giving way and letting in the water?—Yes, quite sure, as the vessel is altogether fastened with iron screw-bolts of large size.

Have you any pumps?—I have powerful pumps provided for.

You mean to say that it is so strongly put together there can be no leak?—Yes, I have provided sufficiently against any leak by caulking inside, and having men overhauling, being three times stronger than any vessel, the cube of every foot in length of eight plankings and bottom gives 135 feet.

Would it not be better, to get rid of all objections, to bring the stone round, and construct it on the spot?—Yes; and in this event the expense of patent vessels might be greatly less than if built to carry the stones from a place much exposed, and at a considerable distance from the proposed harbour.

You think it would be the cheapest plan to bring the vessel round ready built?—Yes, for the freight of the stones would be a continual expense; whereas, if it was built strongly, the whole work might be finished and then brought round, and the work might be carried on, and the same vessels fit to build a dozen harbours afterward.

Do not you think that your vessel would be more manageable and convenient to work if it was only 100 feet or 200 feet rather than 400 feet?—As far as I have seen, with a vessel of 200 feet or 100 feet there is more than double the motion of one with 400 feet in a heavy sea.

Do you calculate on the chances of bad weather, or on the certainty of accomplishing this in fine weather?—I think I am prepared for a pretty good brush. I am fully impressed that I have strength to bear everything up.

You would prefer doing it in a harbour?—I would.

And as near as possible to the spot?—Yes, if the quarry was handy.

Have you ever visited Portland?—No; I am quite a stranger to all that coast.

If you had to construct a harbour at Dover, where should you propose to get your stone?—I should be guided by looking at the chart. If there is good stone at Alderney or Jersey, or anywhere there it would answer best.

Have you had practical experience at sea?—Yes; I have been four times across the Atlantic; the last voyage was in 1805.

Do you think that, if there was a disposition to try your plan, there is any company who would be disposed to join with you in trying it?—I am quite a stranger in the city; and here are so many plans going, that I really cannot say.

If any part of your plan was adopted, would you undertake to become a director and

Mr. *James Bremner* and Mr. *David Bremner*. 11th June, 1844.

managing superintendent of it, being paid a sum of money for your trouble?—Certainly; there would be nothing more agreeable to my mind than that.

(*Sir H. Douglas.*) You would build the inner walls in the same way as the outer?—Yes.

With what will you fill up the spaces between?—I propose doing that with chalk blocks at Dover.

You would fill them up with chalk thrown in promiscuously?—Yes, between the two walls.

What is the slope of the inner wall?—Two inches and a-half to the foot.

How do you sink the inner walls?—In the same way as the outer.

You state that the uniform depth is 45 feet?—Yes, of patent vessels.

And the draught of water 16½ feet?—Yes.

You would begin at low-water mark, and run out the first length of 400 feet?—I would.

Taking Dover Harbour, what depth of water would 400 feet run you into?—I should say 29 feet or 30 feet.

Your first length of breakwater of 400 feet would be sunk on a sloping surface; in that space there would be a difference of 29 feet or 30 feet?—Yes, 1 foot in 14 feet.

How should you manage so that all the foundation of your masonry may be horizontal and the joints vertical?—Before we began to build we should take the exact soundings with rods which we have down on this chart; here is the exact level set down; we begin with the levels at one end and form the foundation; here is the level where it is laid down, and this is the level of high water, (*showing it on the plan.*)

The bottom is formed in one continued slope?—Yes.

How will it be if in a length of 400 feet you meet with a very unequal bottom, so that the difference may be 29 feet at one point, and at another point a still greater inequality?—We take small handy materials, and get sounding rods, and iron rakes, and rake it over and make it smooth and level.

You make the rock smooth?—Yes.

The unity of the work depends upon the consistency of the bottom, because if any part there is soft sand, there will be under washing, and dislocation of the masonry; how will you provide against that?—There will be stones thrown down on the outside, at the foot of the wall after it is sunk.

Suppose a part presses on rock and a part on sand?—The precautions I take completely guard against that.

Do not you think that there will be an under washing where there is sand?—There will be stone thrown in to prevent that, and whenever we find anything soft we shall throw in rubble.

You prepare the ground beforehand with a diving-bell?—No, that is not necessary.

With respect to the construction, its admirable arrangement provides for the strength of the beam, and the lateral strength of the section, but do you not apprehend that this long vessel of 400 feet in length, of which that you have produced is a section, not having either keel or keelson the removing her would create a great danger of breaking her back?—No; she has eight thicknesses of four or five-inch plank; eight coatings in fact in place of four, which is enough for any ship; the height is in very good proportion, and it is all vertical timbers; her strength is much greater in proportion than that of any other ship.

You mean to say that you rely upon the strength of your plank?—Yes; and my diagonal fastenings below timbers.

You have no sleepers?—No, they would be of no use.

What would be the objection to your caissons being made in lengths much less than 400 feet?—None whatever, but that they will work much easier at the full length and be much more easily commanded; the greater the length the easier they will work.

(*Capt. Fisher.*) You state that you have had experience as a seaman, and have been across the Atlantic several times?—I have.

From your experience as a seaman are you not of opinion that very extreme risk would be incurred in navigating a vessel or a caisson of the description you propose, namely, 400 feet long, 100 feet in width, drawing 16½ feet water, and carrying 17,000 tons of material for any distance, and that it would be much preferable in every view that this caisson should be constructed as near as possible where the breakwater is to be formed?—After having given the most mature consideration in my power to this for the past two months, and considering the power of steam, and that we shall be able to get two steamers, or even three, if necessary, I do really think it will be perfectly safe in a length of 400 feet; but, still I perfectly agree that it cannot be without a risk in case it should be attacked on its voyage with a heavy gale of wind. In the summer months this would not be likely to occur.

Have you had any experience of carrying out materials in the way you propose?—Yes.

State on what scale?—About 40 or 50 tons between two old boats which I had bought for 30*s.* a piece.

(*Mr. Walker.*) Are you not aware that the dangerous state in which Westminster Bridge has long been, and which has occasioned, in some years, the outlay of enormous sums of money, is in consequence of the original builder having constructed the piers of that bridge in caissons, that they were taken out and sunk on the sand without any under piling, and that the under washing of that sand occasioned the destruction of one arch, and is the main cause of the enormous outlay now going on on that bridge?—So I have heard.

Is not the system of using floating caissons, such as you propose for laying foundations of masonry of any kind in water, generally abandoned by all civil engineers?—There is

Mr. *James Bremner* and Mr. *David Bremner*.

11th June, 1844.

no doubt that the strength of the run of water might cause a defect in Westminster Bridge, where there is such a rapid current of water; we have not that inconvenience to contend with, and then the continuation of such a long line, and the weighty materials thrown on outside, and the hearting on inside will be a guard against any wash whatever. I certainly do think there will be no risk whatever; with the heaviest buildings there are there is more or less timber about them.—(Mr. *David Bremner.*) I would beg to suggest that the case of a bridge, resting upon small piers, and of a continuous wall like this, are not exactly parallel; the superstructure of the one rests on a very small surface, and the arches being altogether above water throw a very considerable weight on foundation, besides the vibration caused by carriages, waggons, &c., continually passing over. It would not be so with sea walls, resting on a large area of foundation and not subject to vibration of any kind, and the walls battering, all their weight is not laid on their foundations.

Still there could be no under washing without a dislocation of the unity of the masonry?—No, if it yielded to the pressure of the water against it; but, in speaking of Westminster Bridge, the greatest amount of mischief did not occur till the water was pumped out of the coffer-dam.

You refer to the late injury, but the question refers to the original injury, to the washing of the sand?—There is a difference there, certainly; the pier here would have a constant pressure against it, and in the depth of 40 feet of water I do not know that, if done in the manner here proposed with rubble below and outside the bottom of caisson for the pier of bridge alluded to, any such accident would have occurred.

Do you not consider that the vessel would rest on a shaky foundation with two feet depth of timber between the sunk wall deposited and the bottom?—(Mr. *Bremner.*) That I propose getting filled with concrete between the frame and the bottom, but I should remark that it would be only about six inches in depth of timber.

When should you get that done?—When we are building the wall platform, or slip bottom.

Do you propose to have a bottom of wood?—Yes; or of iron under the wooden beams screwed to with bolts, and only leaving the iron plates between masonry and foundation.

How many inches of wood in thickness?—Seven inches for sleepers.

Suppose, in sinking the vessel, the extremes of the fabric on each side took the ground before the centre, from the unevenness of the ground or otherwise, what would be the consequence in your opinion?—The ground is levelled before the work comes there.

Unless such an unwieldy vessel can be placed steadily and evenly across strong tides and winds, will not that which is deposited be liable to form a zigzag or mis-shapen wall consisting of so many joints?—The vessel is so firmly built there is no danger of that; there must be proper winches steadying her; it is impossible with proper care that that can be the case; we must have plenty of winches provided to guard against any danger of that kind.

(*Sir W. Symonds.*) Have you ever calculated what sized chain, and what weight of anchor would be necessary to hold a vessel carrying a weight of 17,400 tons, besides her own gravity, in the event of its being necessary to anchor the vessel?—I have calculated that; it is not so much as may be at first supposed; the vessel having no masts or spars, she does not require half the weight of anchor of other vessels in proportion to her size.

(*Lt.-Col. Alderson.*) In the event of your making your caissons in smaller lengths, could not you make a very considerable use of the concrete for the formation of your construction?—I am perfectly aware that the concrete would form a most important part.

So that, sinking masses of concrete, you might afterwards face them very easily down, and slope them with great masses of stone?—You can never depend on any kind of stone for such constructions unless they are built in proper form; I never could get them to answer without that.

You have never built any breakwater yourself?—I have built not fewer than 10 in most exposed parts; and founded in 8 and 10 feet water at low spring ebb tides, and employed stones of 40 to 50 tons, which brought it to the level of low water in one height; all which stand most secure. Of these my son superintended six breakwaters.

Is there any other paper you wish to produce?—Yes, I have prepared a statement, which I beg permission to read.

The same was read as follows:—

"*To Admiral Sir Thomas Byam Martin, G.C.B., Chairman of the Commission for Harbours of Refuge.*

"SIR,

"When I was honoured, on the 3rd instant, with your desire that I should lay before and explain to you and others of the Commission appointed to survey the south-eastern coast, my plan and models of the same, for building sea-walls in deep water and in the most exposed situations, now secured to me by Her Majesty's letters patent, you requested me to report upon the mode and expense of executing the proposed Harbour of Refuge at Dover, according to the principles of my invention.

"To enable me to comply with this request, in addition to having previously been at Dover, I have obtained a knowledge of the extent and position of the work contemplated, and the particulars of the drawings accompanying, from a lithograph plan, on which the soundings, the nature of the bottom, and the line of the coast adjacent to the proposed harbour are laid down, which, along with a Report by a Commission to the Lords of the Admiralty, was ordered by the House of Commons to be printed June 5, 1840.

"Of the necessity, importance, or effect of having such a harbour as that proposed at Dover, no opinion of mine is required; this part of the subject has very happily fallen into abler hands.

"I will, therefore, refer briefly—1st, to the description; 2nd, to the construction; and, 3rd, to the upholding of the work, according to my ideas.

Mr. *James Bremner* and Mr. *David Bremner*.

11th June, 1844.

" *Description of Building Materials.*

" The outer casings, or the sea and inner walls, shall be of sound and durable stone of large sizes, built header and stretcher alternately in the best lime mortar, close jointed, fair dressed, and set in the manner shown on the accompanying transverse sections, due attention being paid to the bond of every stone; bars of iron 3 inches by 1 inch to be sunk into the courses longitudinally, and vertical bolts 1 inch diameter to be bored for and driven home at intervals of 3 feet, in the way represented on sections; iron tye-bars, 3 inches by 1 inch, to be sunk and fixed transversely into the courses of walls; to these, tye-beams and chains to be fixed to connect both walls securely together. Sections of the sea and inner walls, in lengths of several hundred feet, to be solidly bedded upon the bottom. The interior filling in, or hearting, for which chalk blocks will be sufficient, to be put in promiscuously to the level of low water, and gravel to be used to fill in the interstices in considerable quantities, at suitable heights as the hearting progresses; the same to be continued at every four feet of height above low water, to form a compact and firm mass. The stones of the sea-wall to be entirely built with lime-mortar; but the inside wall to low water only. Tye-beams and chains to be continued above in the same way as under low water.

" The platform or roadway on the top to be paved with stones of sound quality, not less than 8 inches thick, well dressed, set on edge upon a bed of gravel, good lengths, and 18 inches deep. The whole to be wedged with fir wedges in the most firm manner.

" *The Construction of the Work.*

" The work under water, so far as the construction of the walls is concerned, forms the subject-matter of my patent; and any description of how it is proposed to be done will be understood to bear directly on my invention. The walls I propose building in such lengths, varying from 100 to 400 feet in length, as may best answer the bottom. These sections to be built near the quarry, floated off, and sunk in their respective places by means of the full application of my patent. Previous to this, the ground which is to form the foundation is to be examined carefully and sounded with rods, and any inequalities to be made up with small stones of hard quality and irregular shape thrown on top of the place; large iron raking machines worked from barges, then to pass over the surface in all directions, to consolidate and straighten the surface properly.

" Drawings also accompany this Report, showing the mode and principles of construction of the patent vessels (the expense of which has been estimated) to carry out and deposit the under-water walls—the most important and difficult feature of any low-water harbour.

" The unfinished ends of walls to be most carefully closed in, as shown on an accompanying drawing, to prevent any breach by the sea during storms upon the hearting, until the ends are permanently built up similar to the sides.

" At each joining of the various portions of the walls, to which great attention will be paid, bond to be made as shown on the elevation of wall, the one end fitting exactly into the other; long iron bolts to go obliquely from one section into the other, so as to fix and unite them properly together. All the bolting and iron work to be laid flush in Parker's cement, with which the face-joints of the walls are to be pointed.

" The railways and machinery for carrying on and building the materials to be set upon a continuous line of framing, of the description shown on transverse sections. Should it be found necessary, for the sake of dispatch, locomotive steam power to be used for bringing in the waggons.

" Hard stones of various sizes to be put down promiscuously, so as to lay in a body at the foot of the sea-wall for its entire length.

" *Upholding of the Work.*

" With the excellence of the quality and mode of building, and the substance of the proposed walls (each section deposited being like a solid stone of its own dimensions), and their being so firmly bound and tied transversely together, no apprehension need exist of the perfect strength and solidity of the work.

" The slope of the proposed sea-wall is designed with especial care to combine a most firm wall, with offering but little resistance to the force of the sea in stormy weather; the inclination being such as to give the upper portion of the wall a considerable weight upon the lower part, and so preventing the action of the sea from shaking out the stones, which would be the case in a perpendicular wall; or their being torn out, as is often the case on too flat a slope; the waves acting with concussive force *against* the one, and with their whole weight and velocity *upon* the other.

" *Conclusion.*

" The scheme I have the honour to propose for the execution of the work at Dover consists of building large sections of sea-walls near to the quarry, in some place having tolerably smooth water and an even bottom, on which the platforms (called slip-bottoms in my patent) rest; on each of these the masonry may be built at all seasons of the year. Through and beside the masonry strong chains are to be fixed. The patent vessel for the buoying the whole out, is, after the completion of the masonry, taken over and attached thereto by the chains, and also screw bolts at low water. With the rising tide the whole floats may be towed off by a steamer, and by the aid of sails on the patent vessel itself (it may be for some hundred of miles), to the site of buildings; care being taken to have powerful pumping gear, even although the vessel is tightened on the inside planking where men see and can stop, at the time, any leaks that may occur.

" The desired place arrived at, the section of wall to be moored exactly over its berth; at low water, if it should not ground, the patent vessel to be allowed to fill very gradually with water, by means of a screwed sluice at each end of each compartment, by which means the section of the wall may be sunk in any way necessary, until it is known that the wall rests firmly on the bottom, when the screw bolts are so far unscrewed as to be clear of the slip-bottom beams, the chains are then detached, and the vessel is relieved and floats clear, is pumped out, towed or sailed back and fixed on to another section of the wall without loss of time, returns with and deposits it, and so on, while the good weather lasts.

" This carries the walls a little above the level of low water, when, after being secured and bound in the manner aforesaid, the hearting may be inserted; but it shall in no case go in advance of the building, or go in at all until the walls are perfectly secured together.

" A strong feeling may exist as to whether anything can be constructed sufficient to float and remove such a weight of stone as will be necessary for the purpose intended. There can be no doubt of this

Mr. *James Bremner* and Mr. *David Bremner*.

11th June, 1844.

that when old crazy vessels carry heavy cargoes in *bulk*, such as coal, lime, stones, &c., with very bad weather, a vessel of peculiarly strong build can, with comparative ease, carry a very great weight, which is so firmly united as to present one *unbroken* whole, which weight is equally distributed over its whole length.

"A trial of the process, however, will dispel all fears of this kind, and prove the economy of that system by which piers may be built without lighterage or freight of any description, which would otherwise form an important part of the expense necessary to construct a harbour at Dover.

"It may be naturally expected that the description of a scheme in the process of being patented, written by the patentee himself, will contain statements so flattering that they will never be realised. But here I must take the liberty to mention that the same influence that has induced me to apply for and be at the expense of a patent, also induces me to recommend the adoption of my views at Dover, namely, an experience in harbour engineering and building in the most exposed situations in the kingdom of 38 years standing: thus much for practical knowledge of harbours and harbour building. As to ship-building, I have taken off stranded vessels in the most damaged state from most exposed parts of the coast to be repaired; built and repaired vessels of very large burthen: in doing all which my experience has now been extended to nearly half a century. This enables me to know, and, indeed, led me to the design of the patent vessels, what should be done to strengthen them best, and what they are capable of lifting. But to return to this digression.

"Even at Plymouth, where the breakwater is only one half the length, or depth, of that proposed at Dover, and where the hearting used is *good stone*, the cost of execution has been very far beyond what the work could have been more efficiently done for, through the flatness of the slope made by the sea upon materials at first promiscuously tumbled in. And what is to be expected of the soft chalk blocks at Dover, intended to form the body of the breakwater there? Let the same principle of forming the interior, getting it consolidated by the action of the sea, and raising upon it machinery for completing the outer casings at Dover, and it will be entirely ruined as a roadstead or harbour of refuge, from the violence of the sea demolishing and strewing all over the bay the chalk blocks thus thrown in.

"But a very strong proof against the fitness of chalk being exposed to the sea, for any period of time, existed at Dover itself, with an extensive breakwater, built in the time of Henry VIII., which was demolished before it could be completed.

"If placed within lime-built stone walls, with a mixture of flinty gravel, however, there can be no doubt of the sufficiency of chalk as a hearting material.

"The question might be asked how are the walls to be carried out *before* the hearting by diving-bells, or any apparatus ever yet used? With even dry-built stone walls, not bound with long bars of iron, or bolts at all, it is barely possible to be done, and would take rather more than half a century to do, even if the sea should make no ravages on the work.

"But in the strong and complete manner here specified, of doing the work, or, as the nature of the situation, and hearting material would require, would be found utterly impracticable, with these means.

"Contrast with this the short space of six years of ordinarily good weather, which would suffice to complete the whole work in a more substantial manner and at a cost very much less, than by any other way.

"It was bare necessity that led to the discovery of the new principle for building in deep water here explained.

"In executing harbours in most exposed situations it has often fallen to my lot to rebuild and execute works that others had failed to finish; and my attention was thereby called to design and erect very powerful machinery, placed above the reach of the sea, and which gave great dispatch during the short time that favourable weather lasted. At Pulteney Town Harbour, the property of the British Fisheries Society, where I engaged in a most serious undertaking in extending a breakwater by contract, the bay is most exposed, and notwithstanding the excellent machinery there erected, one tide proved almost fatal to the work, a great part of which was demolished, and the bulk of the stones, which are very heavy, and of excellent quality, were carried away a distance of 400 yards, and some of them deposited under water in the entrance, to its great injury. With the utmost difficulty the work was finished next year.

"I was lately applied to for a design to extend that harbour into a still more exposed part of the bay, and much deeper water, at the passing of the Bill, for which work I now attend as engineer.

"Knowing well from past experience there, that unless the piers were erected, each in one season, out of three fathoms water, spring ebbs, the whole would certainly be driven down, I came to invent that without which no machinery ever used could avail to finish the proposed piers,—neither of them exceeding 600 feet in length,—in one year each, failing which they must inevitably be driven down.

"What is here said of myself will be accounted for by the nature of the description, and the invention described.

"The accompanying drawings, four in number, are necessary to show the work as finished, and carrying on, one drawing referring entirely to the patent vessels.

"I made a detailed estimate of the cost of the contemplated harbour at Dover, founded on facts obtained from good authority in London; and it is sent herewith. The cost of the work, if done as shown on transverse sections, and as herein described, would be far under the estimate of the Commission of 1840, while the work would be far more substantially and expeditiously completed than by any other mode of building ever used.

"All the information I can give, you are perfectly welcome to, free of any charge; but to visit and inspect the various quarries that may be most suitable for Dover,—on which alone the prices for an exact estimate could be ascertained, without my travelling expenses being allowed me,—I am not prepared to do.

"Finally, I leave the matter in the hands of the honourable the Commissioners, with this lengthened paper, in the confident hope that in due time it will receive a favonrable consideration, which I only look for on the merits of my invention.

"I have the honour to be, &c.,

"4, *Northumberland Court*,
"*London*, *May* 25, 1844.

"JAMES BREMNER."

Mr. *James Bremner* and Mr. *David Bremner*. 11th June, 1844.

ESTIMATE of the Probable Expense of Building a Harbour of Refuge at Dover, according to a Plan, published by Order of the House of Commons, and agreeably to Cross Sections, proposed by JAMES BREMNER, in connection with his Marine Patent: made out as desired at the Prices he has been building for; and at which the Extension of Pulteney Town Harbour into deep water is estimated.

References.	Dimensions.		£. s. d.	£. s. d.
STONE WORK.				
Sea Wall . under low water	7950·0×15·0×40·0=	4,770,000		
,, . above low water	7950·0× 6·0×33·0=	1,574,100		
Inner Wall . under low water	7950·0×14·0×40·0=	4,452,000		
,, . above low water	7950·0×10·0×22·0=	1,749,000		
		12,545,100 cube feet at 9*d*.	470,441 5 0	
Hearting . under low water	7950·0×84·0×40·0=	26,712,000		
,, . above low water	7950·0×74·0×22·0=	12,942,600		
		39,654,600 cube feet ÷ 27 = 1,468,688 cube yds. at 4*s*.	293,737 12 0	
Sea Wall, East Pier . under low water	1550·0×10·0×15·0=	232,500		
East Pier . above low water	1550·0× 6·0×33 0=	306,900		
Inner Wall, East Pier . under low water	1550·0×10·0×15·0=	232,500		
East Pier . above low water	1550·0×10·0×22·0=	341,000		
		1,112,900 cube feet at 9*d*.	41,733 15 0	
Hearting, East Pier . . .	1550·0×74·0×38·0=	4,358,600 cube feet ÷ 27 = 161,429 cube yds. at 4*s*.	32,285 16 0	
Sea Wall, West Pier . under low water	560·0× 9·0× 8·0=	40,320		
West Pier . above low water	560·0× 6·0×33·0=	110,880		
Inner Wall, West Pier . under low water	560·0×11·0× 8·0=	49,280		
West Pier . above low water	560·0× 9·0×22·0=	110,880		
		311,360 cube feet at 9*d*.	11,676 0 0	
Hearting, West Pier . . .	560·0×74·0×27·0 =	1,118,880 cube feet ÷ 27 = 41,440 cube yds. at 4*s*.	88 0 0	
Roadway Pitching. . . .	10,060·0×67·0=	674,020 super. feet ÷ 9 = 74,891 super. yds. at 5*s*.	18,722 15 0	876,885 3 0
TIMBER WORK.				
Tye Beams .	No. 1590 × 88·0× 1·0× 0·6=	69,960		
,, .	No. 203 × 88·0× 1·0× 0·6=	8,932		
Uprights . .	No. 3710 × 68·0× 0·6× 0·6=	63,070		
,, . .	No. 581 × 42·0× 0·6× 0·6=	6,100		
,, . .	No. 259 × 32·0× 0·6× 0·6=	2,072		
Diagonal Braces	No. 4020 × 31·0× 0·6× 0·3=	15,577		
Top Beams .	No. 670 × 88·0× 1·0× 0·6=	29,480		
		195,191 cube feet at 1*s*. 4*d*. .	13,012 14 8	
Top Planking, 2 inches thick	10,060·0×70·0=	704,200 superficial feet at 3*d*. .	8,802 10 0	21,815 4 8
IRON WORK.				
Longitudinal Flat Bars .	47,700·0× 0·3× 0·1 =	477,000		
Transverse Flat Bars .	56,710·0× 0·3× 0·1 =	567,100		
Perpendicular Bolting .	400,150·0× 0·1 diam. =	1,050,393		
,, .	70,420·0× 0·1 diam. =	184,852		
		2,279,345 lbs. = 1017½ tons at £10.	10,175 0 0	
Chains of all descriptions, second hand, good quality		3720 tons at £8.	29,760 0 0	39,935 0 0
Number Four of Bremner's Patent Vessels for Building Harbour Walls in Deep Water, each estimated at £14,220.			56,880 0 0	
Number Forty-five Slip-Bottoms, each estimated at £497			22,365 0 0	79,245 0 0
Roman Cement, 1000 casks at 10*s*.				500 0 0
				1,018,380 7 8
Add for Contingencies, 10 per Cent.				101,838 0 9
				£1,120,218 8 5

May 25, 1844. E. E. JAMES BREMNER.

Taking the masonry, which is the only part not fully ascertained, at 1*s*. 3*d*., instead of 9*d*. per cube foot, as at Pulteney Town Harbour, with 10 per cent. on the difference, would make the full amount £1,552,370.

(*Chairman.*) Are you aware of Mr. Cubitt's plan for constructing a breakwater at Dover?—I am not.

(*Lt.-Col. Alderson.*) Notwithstanding the strong trussed framing by which the chamber on each side of the centre chamber is supported, do you think that, in case of a heavy sea, the connexion between the bottom, which is to be afterwards detached, and the fixed bottoms, is such as to prevent any danger of the vessel leaking at the connexion between the two?—No; I think there is no danger of that.

You think that that is prevented by the strength of the screws which connect the parts together?—Yes; there are 16 feet of shiftings. The transverse tye-chains go right through the walls to the extreme height of the vessel's gunwales, which keep up the weight, as well as heaving down and together both sides of the vessel at the same time.

Is there sufficient strength to keep the extreme ends in the direction of the width

Mr. *James Bremner* and Mr. *David Bremner*.

11th June, 1844.

drawn from the timber trussing. Do you depend upon that or the chains?—Principally upon the chains; but it all helps considerably, and the screwing keeps the whole together.

Have the timber trusses which terminate at the king-posts any powerful resistance in keeping the two extreme ends?—They have a great deal, by means of this connexion, and being firmly bolted with the timbers they cross.

In your model you show a projection outside the section of the stone; what does that mean?—They are beams of 14 inches running longitudinally. There are beams from end to end, bolted through the mass of stone, and down through the slip bottom.

They are crossed by what?—By other pieces bolted to them, so that the whole is bolted into one mass; so that, by iron bolts crossing it in various directions, the stone-work forms one connected mass.

Supposing there be no sand over the chalk rock where you deposit your caissons, do not you apprehend danger from the worm attacking your caisson's bottom?—There would certainly be some danger of that, but we should fill in between the slip bottom on both sides with concrete before the building goes on; besides, it may be made of plate iron entirely, and thus provide a mass outside which will protect it, and the tye-chains in the heart connect the walls together; so that I cannot imagine any great danger from that source.

How low under low water have you known the worm to affect timber?—Very low indeed; 19 or 20 feet, or more than that.

Have you known it at 40 feet?—I do not remember any case so low as 40 feet which has come under my notice. I have known ships drawing 14 feet with their bottoms affected when they have come across the Atlantic, before the coppering was introduced.

Supposing that this should not be eaten by the worm, still it will perish in time?—Yes; but before that time the work will have got properly consolidated into a solid body.

Have you known fresh timber, when sunk and kept constantly under the water, perish?—No, I never have. In the year 1807 I took to pieces the "Centurion," which had been round the world with Captain Cook: she must of course have been very old, but I could see no decay in her timbers in the bottom.

Do you apprehend no danger in case of this being deposited on soft sand?—The pressure being downwards where the building is, of ccurse that would be a complete preventive to the escape of the sand, and the mass of the materials on the outside would have its effect. The sinking does not take place in a sandy bottom unless the sand escapes.

What timber stands best under water?—I dare say there is nothing better than elm or Scots beech, or birch of any kind.

Which is best?—I think there is nothing better than English elm or Scotch beech.

[*The Witness withdrew.*]

Jas. Steward, Esq.

James Steward, Esq., examined.

(*Chairman.*) Where do you reside?—At Dover.

Have you suggested any plan of a breakwater at Dover?—Not of a breakwater, but of piers to enclose the bay, with the exception of a capacious entrance at about south-east.

Into what depth of water do you go?—Into six fathoms at low water.

Enclosing what area?—450 acres.

Do you not think that two entrances would be desirable—an eastern entrance, as well as the one you propose?—With respect to an eastern entrance my own mind is undecided; it must be admitted that an eastern entrance would allow of sea-entering, that would make the harbour more turbulent, and perhaps in time admit the shingle; while on the other hand it would possess certain advantages, especially considering that the ground which I propose to enclose is a roadstead now, and that a very considerable number of vessels use it with the wind at north, sailing from it when the wind comes round; hence, if they are occupying the ground in the eastern part of the harbour, when the wind comes round to the westward they will necessarily have to warp or tack to the westward in order to get out, with an entrance only at south-east; but if there were a small eastern entrance in about four fathoms, vessels bound to the northward would pass out of the harbour with greater facility when the wind was fair for them to sail after having been wind-bound.

What is the mode you propose for constructing your work?—It is fully described in my printed report, from which I will, with permission, read an extract, which will be more concise, probably, than any answer I could give. Referring you to plan No. 2, it will be observed the proposed piers enclose upwards of 450 acres, the harbour being in length nearly a mile and a half, and the distance of its entrance from the shore 1100 yards. Of its two piers, the western pier is in length 1630 yards, its width at top 32 feet, and its height, exclusive of parapet, 10 feet above high-water level, and the eastern pier, in length 1330 yards, of the same width at top and height as the western pier,* leaving an entrance of 1000 feet at about south-east, a point of the compass from which, it being immediately across Channel, Dover Bay is known to be least assailed by winds and seas.

Is not that a wide entrance?—I have left a very capacious entrance in consequence of the difficulty which otherwise might occur from vessels having to work in and out at one entrance. I think there would be no objection to so wide an entrance, as there is very little sea in Dover Bay with the wind at south-east.

What slope do you give to your sea-front?—The proposed work not being simply a breakwater, but piers, the inclination of their sides is 75 degrees, as explained by one of my

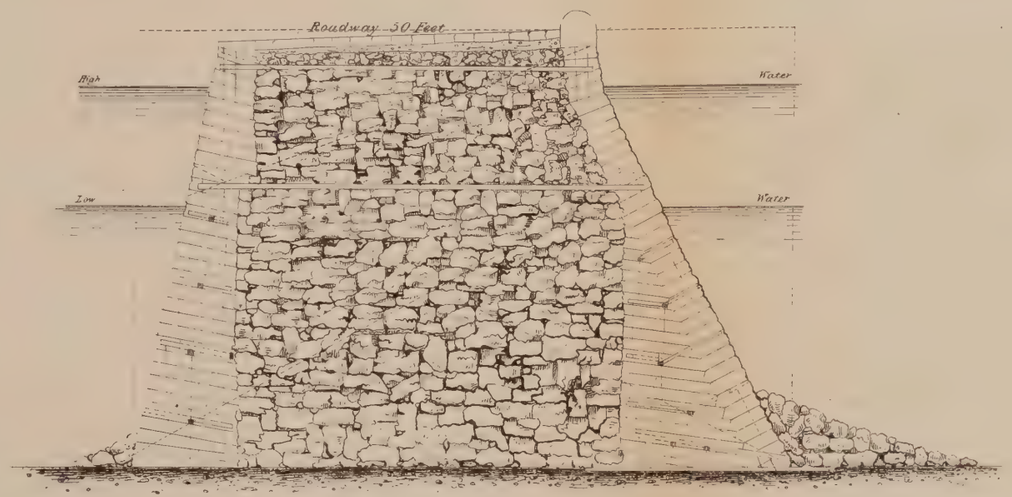
* Should it be thought that the width of the eastern pier may, not having wharfs, &c., be less than the western pier, such an alteration in the plan would of course materially lessen the stated amount of the cost of the proposed work.

To face page 134 in Evidence.

PROPOSAL FOR BUILDING HARBOURS OF REFUGE.

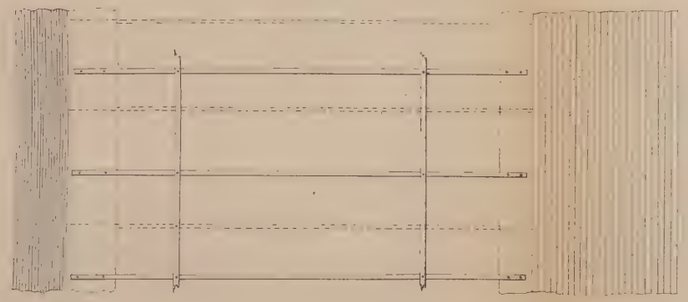
REFERRED TO IN A REPORT BY JAMES BRENNER 1844.

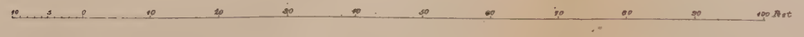
SECTION OF PROPOSED PIER.



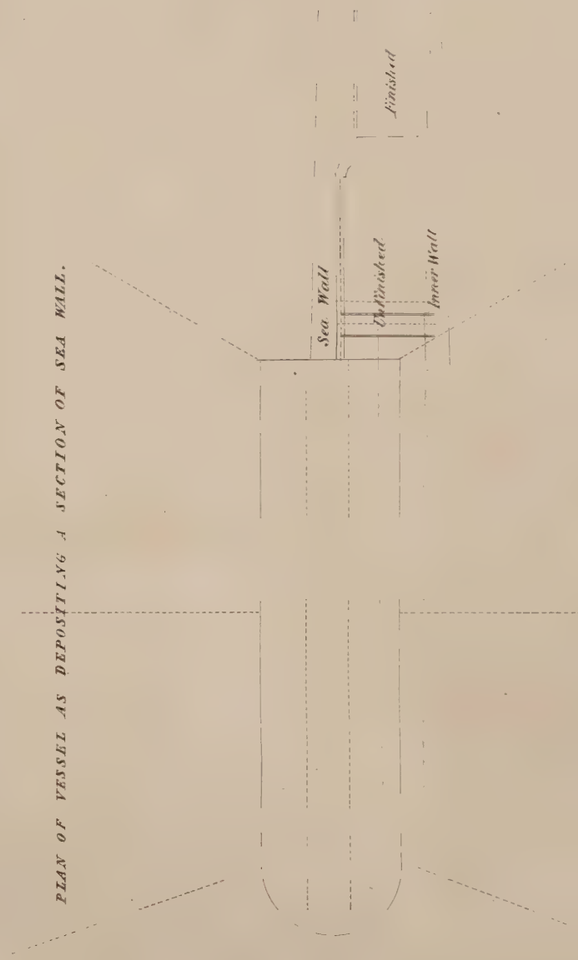
Horizontal section of a wall shewing mode of binding by Timbers

Horizontal section of Walls shewing mode of Tying.

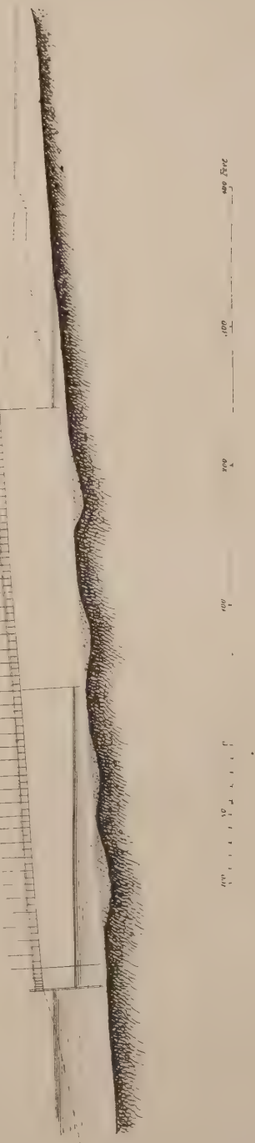




PLAN OF VESSEL AS DEPOSITING A SECTION OF SEA WALL.



Section shewing Vessel laying section of Wall on sloping bottom originally uneven, made straight as described.



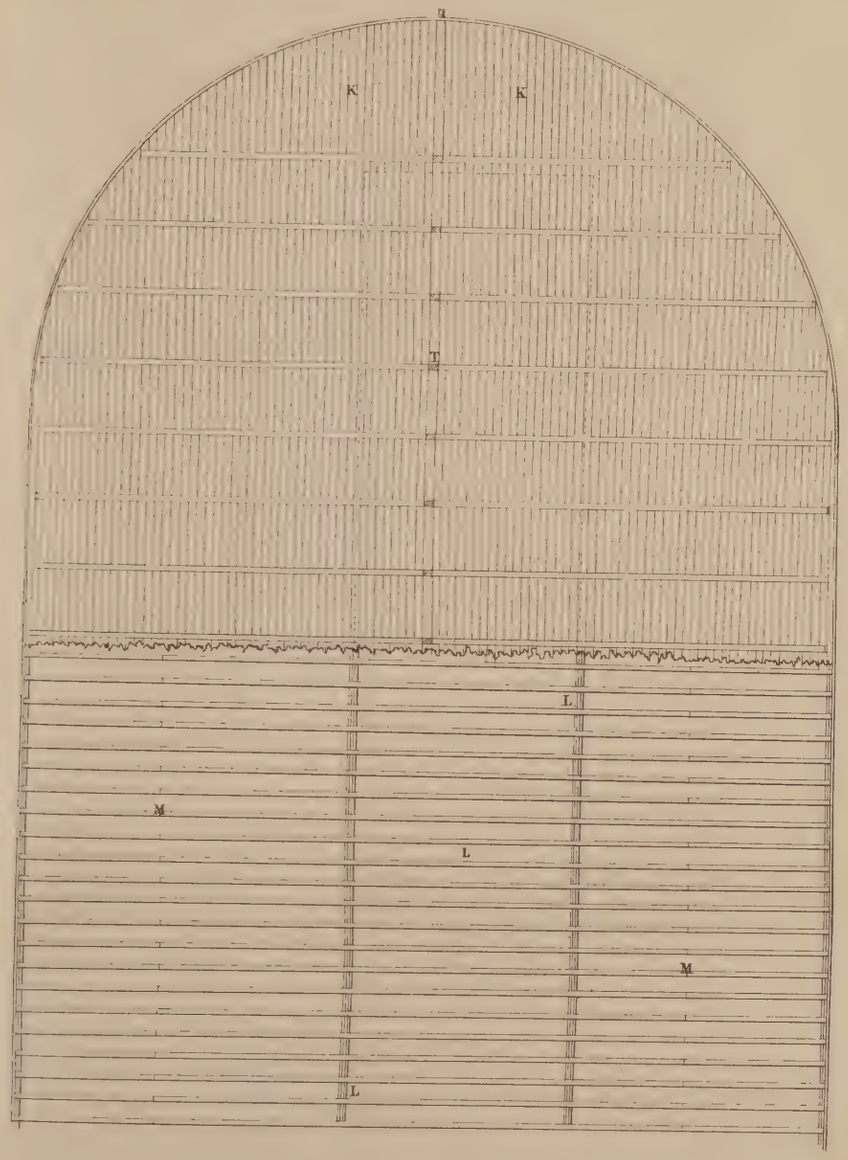
Stephenson & Co. Fetter Lane London.

to face page 153 in Evidence

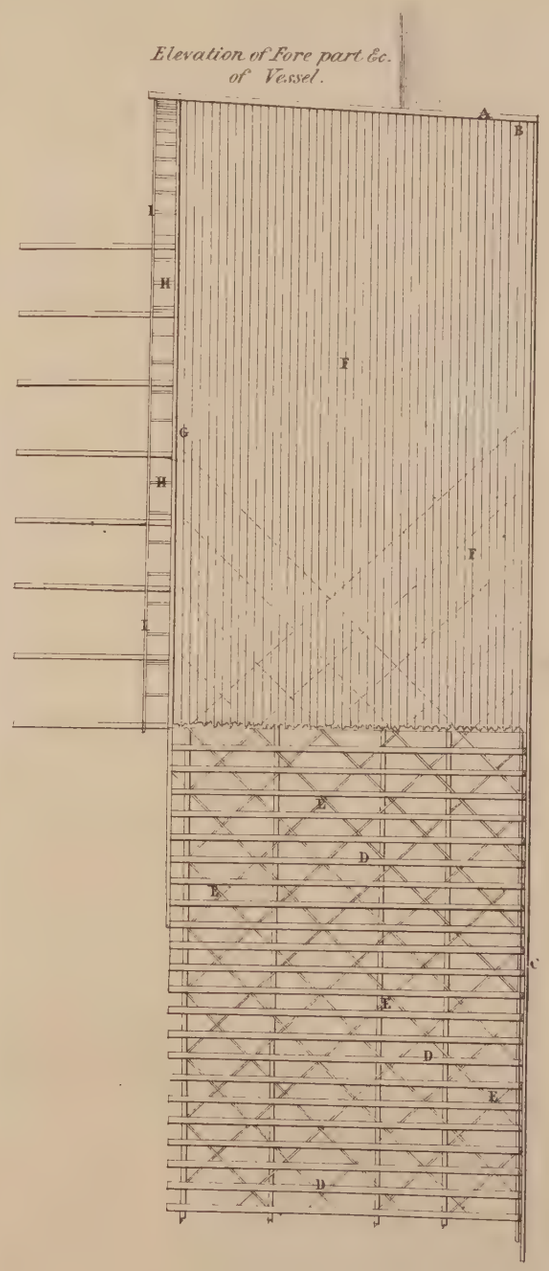
PROPOSAL FOR BUILDING HARBOURS OF REFUGE.

REFERRED TO IN A REPORT BY JAMES BREMNER 1844.

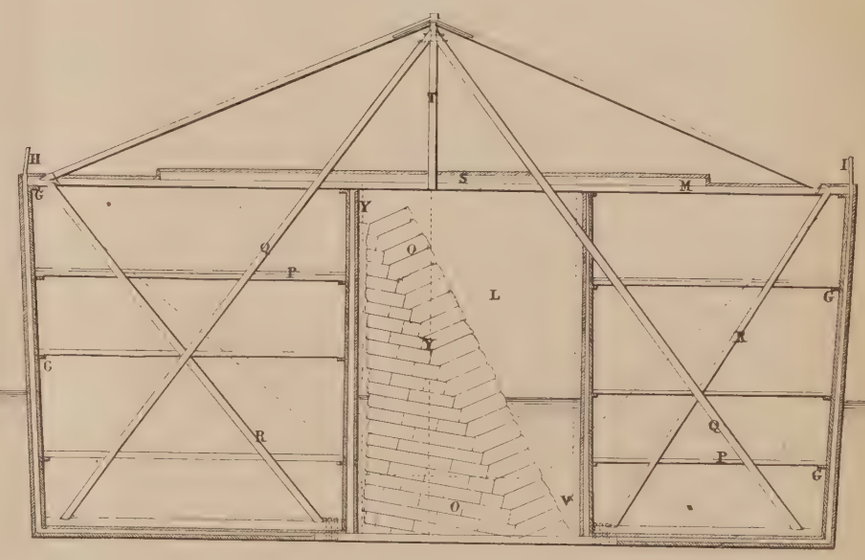
Plan shewing portion of Fore part, trussed beams, deck beams compartments &c. of Vessel.



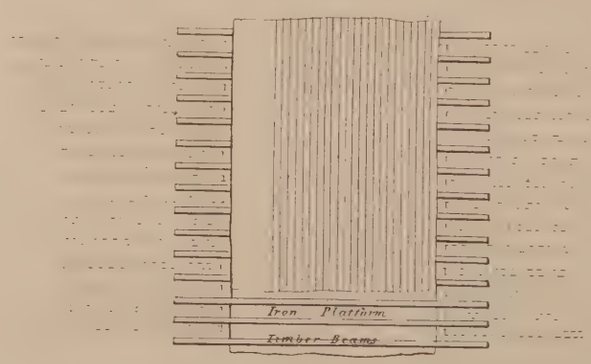
Elevation of Fore part &c. of Vessel.



Transverse Section of Vessel Sea wall, &c. afloat.



Plan of Sea wall, Ship bottom, and position of Vessels floors.



10 5 0 10 20 30 40 50 60 70 80 90 100 Feet

Smith Taylor & Co's Lith. London

plans and sections, which I beg to produce. (*The Witness produced several plans and sections, Nos.* 1, 2, 3, 4, *and* 5.) The western pier is projected from the land from Cheeseman's Head, (which is 170 yards to the westward of the entrance of the present harbour,) and is carried out upon such a principle as that the waves of the prevailing winds, from south to south-west, should impinge upon the western side of this pier to drive any accumulations of shingle there to take place, not round the pier, but to the shore, and so oblige this hitherto intractable enemy to a harbour at Dover to deposit itself in Haycliffe Bay, (on the plan styled prospectively Shingle Bay,) the whole of which must become filled up before deposits of arrested travelling shingle there could threaten to pass round the side of this pier to the entrance of the new harbour: for it is very important that it should be here remarked, that the travelling shingle *is alone propelled by the wave*, at the acute angle which the wave forms with the shore, or with projections or deposits extending from the shore, *and that it never moves under water:* so that, in order to their being any danger of accumulations of shingle against the western pier in time reaching the entrance of the proposed harbour, the shore of Haycliffe, or Shingle Bay, must first become gradually advanced by such accumulations a quarter of a mile seaward, or even more! which, looking at the depth of water in that Bay, would take many centuries: a fact perfectly apparent to persons well acquainted with the phenomenon of the travelling shingle and its effects, and one which affords an incontrovertible answer to all difficulties which have been offered on this subject.

Of the eastern pier I have only to remark, that it would be carried out from the shore at a part (the East Cliff) where its principal material, blocks of the hardest chalk, would be found immediately at hand; and that hence, and from the sea-bottom here being very favourable to contemplated operations, it would be reasonably and expeditiously erected. The depth of water in the proposed harbour will be observed, from the soundings marked on this plan in feet at low water of spring tides (taken from the survey of Captain Bullock, R. N.,) to be, at 400 yards from the shore, two fathoms, and at 1100 yards, six fathoms; so that, of its area, 320 acres would have from six to two fathoms at low water, and 130 acres under two fathoms.

With these general remarks as to the advantages, site, &c., of the proposed harbour, and its piers, I must pass to the important subject of construction, referring the Commission to the plans No. 3 and 4,—a glance at which will inform you that my pier design embraces the novel feature of my invention of the ponderous-footed pile, (in the present design a granite foot,) in respect to which I must, as an amateur engineer, entreat your liberal consideration; though, as regards the proposed piers, its principle being so simple, and its advantages and economy so apparent, I may venture to present it to your strictest investigation. Of my pier plan generally I must observe, that the great principles I have had in view in planning its construction (in the details of which, and in its calculations of cost, I have been ably assisted by Mr. Alexander Dawson, a Civil Engineer) have been—strength, durability, facility of construction, and reasonableness of cost; that its constituents are, blocks of the hardest chalk, concrete, iron, and stone, in parts so arranged as to form in construction a structure of immense strength, easy of execution, and calculated to last for ages; while its cost will be satisfactorily shown to be so comparatively small, from its peculiar design, and the present extraordinary low price at which its iron piles, and other iron work, can be contracted for, (say from 5*l.* to 6*l.* per ton,) as to recommend it, I trust, most powerfully to the consideration of the Commission and of the Government.

Referring the Commission to the general dimensions of piers, and their constituents, at foot of plan No. 3, I will now endeavour to furnish you with the fullest particulars of each specified part. And first, of the iron piles for piers. Their shape and dimensions will be found fully given in the details plan No. 4. The weight of iron is 120 lbs. to the lineal foot; giving, it is considered, an abundant strength, and ensuring durability. Inquiries have been made as to their being cast, and it is found they can, if desired, be cast in lengths of from 50 to 60 feet; but as their structure presents a simple mode of junction, (explained by the elevations A and B on No. 4 plan,) the casting in great lengths may not be considered desirable.* Of the application of these piles it is unnecessary to offer remark: their general advantages, and superiority to piles of wood, (as in my first pier design,) are self-evident.

The ponderous feet of piles for a clay bottom, which will be found to exist on the proposed site for piers, where a chalk bottom (which prevails most) does not occur, are composed of granite, their dimensions being 5 feet high by 4 feet square, and their shape and weight designed to plant them firmly in the subsoil; this simple invention, affording to pile-work a foundation at a small cost, equal in security, it is apprehended, to a massive one of masonry of stone. The size of the feet of piles can of course be increased or diminished, as deemed advisable. The foot of pile for a chalk bottom is of iron, for the insertion of which in the chalk a small chamber, by a simple process, would be made. The interior of the piers is composed, to low-water level, of large square blocks of the hardest chalk for the outsides of the foundation, regularly bonded, the weights of which would average from one to two tons, (the chalk rock of East Cliff being of the hardest and best quality in the district,) and be furnished immediately contiguous to each proposed pier, where chalk quarries could be purchased for about 500*l.* respectively. The chalk blocks would be lowered into their berths from the pier platform of operations, down inclined conducting timbers, which would be so adjusted as to determine, with the greatest precision, without the use of the diving-bell, their exact position below, where, when placed, they would be secured from waste through any action upon them of the sea, by the stone casing in the grooves of piles, and form, so protected, an excellent and reasonable foundation. The foundation within the outside blocks of chalk, to low-water level, excepting one course of chalk blocks terminating it, is rubble chalk, in lumps averaging from a quarter to one ton, cast in

* An elevation of a hollow pile will be also found on the details plan.

Jas. Steward, Esq.

11th June, 1844.

from the pier platform, and allowed to dispose itself and settle in the space between the outsides, the interstices being filled up with fine shingle, forming a foundation, in conjunction with the outside blocks of squared and bonded chalk, of the firmest nature, and expeditious of execution. The interior core above low-water level is of rubble chalk, grouted with concrete; the grouting in proportions of six of shingle, two of sand, and one of cement. This core is designed with a view at once to economy, by a saving of concrete, and, as being grouted, possessing a compactness and strength little inferior to the concrete which encloses it: its width at top is 10 feet, and at bottom 25 feet; which dimensions, it may perhaps be considered, may, without any diminution of the strength of the interior of the pier, be increased; whereby a saving would of course be made. The concrete sides, which enclose the core, and back the stone slabs in grooves of piles, is composed of shingle, cement, and sand, in proportions of four of shingle, one of cement, and two of sand; this description of concrete being used from its greater strength, and having no disposition to expand, as does concrete formed with lime: it would, as made, be cast down from the platform into the space between the core, as erected, and stone slabs, simultaneously placed in the grooves of piles; and there form, in conjunction with them, an interior equal to one of stone masonry: indeed, the nature of this composition is such, that if it be properly prepared and applied, (blocks of chalk being cast in on the top of each adhering layer, so timed as to key them together as they are cast,) it will ultimately form a mass equal to one immense stone, from the top of the pier to its foundation of chalk, wedging the interior core and the stone facing! And here, I trust, I shall be pardoned in calling the particular attention of the Commission to the combined effect of the constituents of the interior of the pier proposed by me, and now under description. Looking at the transverse section of the design submitted to you, and considering what has been detailed, and is there presented to your view, I trust you will be able to pronounce—as I may venture to say others, of no mean judgment, have done—that the interior construction of my piers presents A ROCK OF STRENGTH, which, protected from waste by the stone casing, is at once calculated to resist the utmost powers of the elements to assail it, and to prove of the most lasting kind. The granite key-blocks, for fixing the chairs which secure the piles, are three in number in the design, on each side of the pier. Their dimensions are 6 feet by 4, with about 10 feet in the clear between each course—when the depth of water increases to about five fathoms, an additional course of these key-blocks is proposed;—and it is only necessary to add that, in conjunction with the iron chairs, it is presumed they will form, as embedded in the concrete, a tie to the iron piles, which, for security and compactness, cannot be surpassed by any other invention. The cast-iron chair will speak for itself under its delineation given in the details plan. The stone casing in grooves of piles is of the best Arbroath stone, four inches thick; a substance of stone which, when backed with the concrete, will have all necessary strength, and when placed in the grooves of piles will form a lateral wedge and tie from the top to the bottom of them, rendering all other lateral ties quite unnecessary, and affording to the assistance of the principle of the ponderous-footed piles an immense weight *in them*, which will be calculated to ensure their final settling and stability. The fender beams are of oak, 14 inches square. The mode of securing them to the piles is fully explained in the details plan, and their position is shown in plan No. 3. The granite parapet and curb—of which the dimensions are given on the plan No. 3—require no particular comment; nor do, perhaps, the other minor matters of finish, which are of the usual kind.

What do you understand to be the quality of the holding ground of Dover?—I believe that the soundings prove that the bottom is chalk and strong loam or clay.

Do you understand it to be fair good holding-ground?—Part of it particularly so; that part where the valley opens looking through the valley is considered very good holding-ground, beyond that, the ground is very hard, and vessels require anchors of a particular description, I believe, to hold in a chalk bottom, but much of the ground in the bay is good holding-ground.

Do you speak to that from your own knowledge or from hearsay?—Not from my own knowledge as having sounded the bottom, but from having lived many years opposite the bay and observed the effects of gales of wind on ships anchored in the bay.

Are you a seaman by profession?—No; I have become acquainted with nautical matters from having lived much of my time at the river and sea-side, and having many connexions with shipping interests.

Your proposal goes only to the erection of a harbour in Dover Roads?—I apprehend that my mode of erection is applicable to other sites as well as to that of Dover, where chalk or stone can be easily procured.

Have you turned your attention to the erecion of asylum harbours on any other part of the coast?—No; no other part than Dover where I have resided for some time, and which place, I consider, for the reasons I have assigned in my report, (to which, on this subject, I beg respectfully to refer the Commission,) more eligible than any other situation on the south-eastern coast for a harbour of refuge. (*Mr. Steward delivered in printed copies of his Report.*)

Have you anything to say more than you stated before the Committee on Shipwrecks?—I do not wish to confine myself to the evidence I gave before the Shipwreck Committee, for I had not an opportunity of going into the subject so fully as I should have wished, and I should rather refer to my printed report now before this Commission. I was the first witness examined on harbours of refuge, and the committee, at that time, were not so well disposed to entertain the subject of the erection of harbours of refuge as they became afterwards. I beg to add, that from an error of print in the Shipwreck Committee Report, the entrance of my proposed harbour at Dover is stated to be 30 instead of 1000 feet.

(*Lieut.-Col. Alderson.*) You produce a section of your pier plan, where is the four-inch

stone casing which you describe as being let in between the piles?—It is shown in the front, (*pointing it out,*) but cannot be shown on the transverse section; it will be seen in the details plan.

What are those two strong wales introduced for?—They are the fender beams; they are not necessary as lateral tyes; the stone facing is a vertical lateral tye; it is impossible the piles can move one way or another.

Of what are they composed?—They are of oak.

Of what size?—14 inches square; the mode of fixing them is explained in the details plan.

The whole of the filling up behind the iron piles below water is intended to be done without the use of a coffer-dam or caisson?—Yes; I apprehend by the aid of a simple moveable platform of operations, the foundation below water could be properly deposited without seeing the bottom at all. I should propose to commence the work from the shore, and to carry it gradually out by means of a platform, by building a caisson, planting it at 50 feet distance as a buttress to the platform, the horizontal side timbers of which platform would be so adjusted as to regulate with the greatest precision the planting of the piles of the section in progress, which would be the first operation. The piles of the section being planted and secured, the next operation would be lowering the blocks which form the foundation to low water level; we know the exact content of the bottom, and by using inclined conducting timbers from the platform, down which to lower the foundation blocks, apportioned to the content of the bottom, they would be placed in their proper position; the mode will be so very simple, that I think they can be laid with the greatest exactness without the use of the diving-bell; the outside blocks being placed, the others can be laid as a matter of course, and the rubble be thrown into the interior. The work, above this foundation, would be a large concreted mass, backing the stone facing simultaneously, inserted in the grooves of piles, forming a body of great strength; it will be equal in strength to one great stone; it will be of immense strength.

What is the base of your piers?—The base would depend upon the depth of water; they are 32 feet in width at top, and have an inclination of 15 degrees from the perpendicular.

Did you say, that from the finishing course of your chalk foundation blocks, you propose all above to be concrete?—Not exactly so; it is all concreted, being concrete and a core grouted with concrete with a view to economy.

Is there any concreting below low water level?—None.

You build then on the body formed by the blocks of chalk?—Yes.

What will be the size of the blocks of chalk?—They would be irregular masses, as before stated.

Is all your iron cast-iron?—All the iron proposed in the plan is; but, I have to mention, that since this plan was made, I have thought it might be rendered more reasonable, if instead of the iron chain tyes and blocks of granite in which they are fixed, as we have no stone at Dover, and the chalk would not be sufficiently hard for this purpose, wrought-iron bar tyes from side to side were substituted, which would be much more reasonable, and perhaps equal in strength, to the mode of securing the piles before described. The first plan I conceived of (plan No. 5,) had piles of wood and tyes of wood which were very strong. I am disposed to recur to this mode of tying shown on this plan, (*producing it,*) only having an iron tye and iron piles; I think this tye would be as strong perhaps as the iron chair and granite block tye. If it be considered that the iron piles would decay, still it must be admitted, that the proposed work would form a nucleus for an ultimate stone casing from top to bottom, but I should say a century must pass over before this casing or any material repairs can be required to a work of this kind.

You suppose the whole to be so consolidated, as at the end of a century to allow of its having an ultimate stone casing of masonry; how long will iron last in water?—I am not prepared to say how long iron will last in water, but I am aware that iron is deteriorated by sea-water.

(*Mr. Walker.*) Have you ascertained that blocks of chalk as regular and as large as those you have shown upon your plan, can be obtained for such a work as this at Dover?—I think they can be procured with great facility, our cliffs are intersected with layers of flint, and taking that to show the probable split of the chalk, I should say, we could get blocks of any required size, and of a nature very little inferior to stone.

In what part of the cliff should you find it?—At the East Cliff, which is the property of Lord Guildford, and also in the neighbourhood of Archcliff Fort, and the old Folkstone Road.

What is the water shown here behind, in Plan No. 1?—The Pent, which has been greatly improved by a stone quay lately erected.

What will be the expense incurred in carrying out your plan?—Under a million; I have stated it in my report, and accompanying estimate for erecting the two piers described, with their lighthouses, wharfs, landing places, cranes, and every appurtenance specified, at the sum of 833,570*l.* I should say it would be under that sum, assuming that the alterations I have suggested would reduce the amount. If there were any doubts as to the facility of constructing my piers, I could show the Commission the plan I have now with me of my platform of operations, by which I could demonstrate that it would be very easily and expeditiously carried out.

[*The Witness withdrew.*]

Mr. *Henry Barrett.*

11th June, 1844.

Mr. *Henry Barrett*, Author of a Treatise on Bars, &c., examined.

(*Chairman.*) Where do you reside?—In the Commercial Road.

What is your occupation?—My occupation is that of an arbitrator and settler of salvages, and a surveyor of ships, &c.

You appear to have given much attention to the subject of bar harbours, and the construction of breakwaters?—I have for very many years.

Have the goodness to state your opinion as to the cause of the formation of bars?—My opinion as to the cause of the formation of bars is that the egress or the outgoing current is the cause; that wherever the water passes out of a river to sea, either by a natural or artificial impetus, with a sufficient velocity to carry matter in suspension, and that water expends itself, becomes inert or causes a conflicting action with the water of the ocean, then the matter drops and forms a bar, and, on the contrary, where the egress water passes out so inert that it carries nothing with it there can be no bar at the entrance of a harbour.

It appears that you consider all scouring by egress water, whether natural or artificial, injurious?—Certainly; I consider that all scouring water, whether natural or artificial, is injurious, inasmuch as it causes a deposit or accumulation of bar.

If the ebb tide, or sluice water, can be carried so far out as to meet the deep water in the sea, will not such a current cleanse the channels through which it passes?—If the water passes to sea with a sufficient velocity to carry it into deep water, and pass its contents into the coast tide of the ocean, it would no doubt go away into deep water, and form no bar. We have an example of that particularly at Milford Haven (and other ports), where the egress tide passes out, and immediately on its passing St. Ann's Head it goes into deep water, and falls into 18 or 20 fathoms, and the alluvial or other matter is so scattered about that there is no visible deposit at the entrance of the haven.

Your observation applies wholly or principally to a flat shore in front of a harbour?—Principally so.

To a case where the ebbing tide does not reach the deep water?—Yes, wherever there are bars there is generally a flat shore.

Why do you object, as stated in your pamphlet, to extending piers out seaward to conduct the tide into deep water?—I am not aware that I have objected to them, unless where they interrupt the tides, and so cause the water to make a deposit.

You are understood to have said, that a pier of that kind is an absurdity?—No, on the contrary I think there are means in many cases of so constructing piers as to convey the water to sea without injury, or leaving any deposit at the entrance of a harbour.

Suppose, where the ebb tide or sluicing power ceases, a dredging vessel were to be used, would not that prevent the bar?—I fear that such would be the quantity of deposit that no dredging vessel could keep the coast clear, or the bottom of the sea where the deposit took place; but it would be much easier to prevent a deposit than to remove a bar which had already accumulated.

You admit that if the ebb tide or the sluicing power could be made to run into deep water, such tide or sluicing power might be useful?—I beg to be understood distinctly to give an opinion that water has a scouring power where it passes through a defined space, with sufficient velocity to disturb the alluvial soil in the bed of the river, or that which has been brought in by the previous tide, but so soon as it expands itself in the ocean it immediately drops that which is carried in suspension; as I have before stated, that if the ebb water goes out with sufficient velocity to carry the matter in suspension into deep water there can be no deposit; but, in that case, I am not aware that a scouring power can be of any utility.

You have said all bays have a deposit which tends to decrease the depth of water, to what bays particularly do you allude?—I allude to Dover Bay, to the bay in Lowestoff South Roads, and to many bays in the Baltic and throughout the world.

Does the observation apply to any bay of any description?—To all bays; I am not aware of any exception. Take Dublin Bay as another example, from the constant deposition of sand which takes place there. In the Harbour of Kingstown, which has been built on much the same principle as Ramsgate Harbour, although there is a deposit in the inside there is no barrier or bar on the outside, for the water falls out so slowly that it carries no matter into the sea, but the disembogueing water from the Liffy drops the matter it brings down and forms a bar. The whole of Dublin Bay, like other bays, has lessened its depth of water, so it is with the Downs. In passing to Ramsgate, the depth of water has decreased very much there during the last 50 years.

According to your notion there is an objection against constructing any artificial harbour?—No, I do not go to that extent.

If they are built up only to be silted afterwards, what is their use?—I think there are means of letting out a backwater without its passing through the ship channel.

By what means?—By a tunnel or a lateral cut into the sea, taking care that there shall be no water go out at the ship entrance.

If you were called upon to construct a harbour in Dover Bay, how would you guard against this deposition of mud?—I am quite opposed to the principle of constructing harbours in the sea, for I think it is totally unnecessary. I have here a plan of a harbour which is proposed to be constructed at Holyhead (*producing the same*), the principle of this I object to. I am of opinion that in place of a harbour being constructed outside, the inner harbour ought to be deepened so as to form a good and safe harbour.

What is the nature of your objection to forming a harbour outside, as shown in the plan now before you?—I have two objections; the first is the enormous expense, and the next is the length of time it must necessarily take to construct such a harbour. I am of opinion

Mr. *Henry Barrett.*

11th June, 1844.

that all the advantages which such a harbour would afford, if it were constructed, might be obtained by deepening the inner harbour, with two piers constructed, as might be determined on, and where they would operate, and in a direction most advantageously.

The harbour you speak of would be a tidal harbour, would it not?—No, you might carry the piers into deep water, so as to have 14 feet at the entrance at low water.

In point of fact, your piers would form an outward harbour?—Yes.

Then you do away your objection to an outward harbour, or you propose a harbour of a smaller description on the outside?—The piers I propose would not form an outward harbour, but merely, as in all other objects of piers, to form a channel from sea into the harbour. Then there is another objection, and that is the great deposit which would take place in the large area of the proposed sea harbour every tide, and which must necessarily be attended with considerable expense periodically to dredge.

Would not the same deposit take place with yours?—Not to the same extent, for the water would fall in with less velocity; a large portion of the deposit which would fall in this area, (*pointing to the plan,*) now falls there, but the deposit would not be half so much in the inner harbour.

Those are your objections to the proposed harbour at Holyhead?—My opinion also is that, in spite of all that could be done, a very considerable sea would roll in, as it does on the opposite side of the channel in Kingstown Harbour, where the ships knock themselves to pieces at times. With the large opening which is proposed at Holyhead the sea would roll in when the wind came from the northward and eastward.

What length is it proposed to be?—350 feet.

You think 350 feet sufficient to create this disturbance inside?—Unquestionably it does so in the harbour at Kingstown and at Scarborough, and other harbours so formed.

When you compare the exposure to the action of the sea on the harbour at Holyhead by the proposed plan, and that at Kingstown, what distance, with an easterly wind, is there from the entrance of Kingstown Harbour to the nearest land?—Kingstown Harbour is built on the shore, where the sea does not fall very heavy as it does at Holyhead; there is nothing to fend off but the Isle of Man.

Do you know the distance from the proposed entrance at Holyhead to the nearest land at right angles?—I am aware of no land nearer than the Lancashire coast, I believe, from Holyhead along to Beaumaris or the Great Orme's Head; there would be no shelter for this harbour. I am not aware of any land on the Welsh coast that extends sufficiently to the northward to form a protection to break off the sea from this proposed entrance. The simple remedy in Dublin Bay would be a breakwater in front of the entrance, to prevent the sea rolling in.

The space for entrance is 800 feet, might they narrow that to 300?—That might be done, or if one pier lapped over the other that would have the same effect.

Having done with Kingstown and Holyhead, what would you propose to do at Dover to convert the present harbour into a useful harbour?—May I first beg leave to state why I object to a harbour being made on this principle, *i. e.*, according to this plan, in Dover Bay. Captain Ladd put forth a plan (which I possess) some years ago to environ the pier head with a wall, in shallow water, but I am quite sure that the tides passing along the coast would be interrupted, and cause a rapid deposit of sand in the harbour. In spite of all you could do, there would be a very large sea rolling in, and sometimes when the wind came round to the westward, it would come in at the west opening, as shown upon the plan; but my great objection applies to the enormous expense, and the length of time for construction. I know very well that there is so much sea often rolling into Dover Bay that they would be stopped in their works for weeks. I beg to say that if it was thought worth while to improve Dover Harbour, I think all the advantages which could be obtained by that long process, might be accomplished by extending the Dover piers further into the sea.

That is by extending the harbour in a different way from that proposed?—Yes, extending the piers southward into 10, 12, 14, or 15 feet water, at low water, that would make it adequate for all the coasting and foreign trade, which would be an important improvement.

Supposing that you extended the piers at Dover in the way you propose, how could it be a harbour of refuge for ships coming in?—There would be plenty of room, and you might make the harbour 16 feet deep at low water, all the way up to the inner bridge, by excavations.

You would propose to enlarge the harbour and deepen it?—Yes.

Do you propose that as a matter of economy?—I apprehend that it would be done at a much less expense than that which is proposed, building out a great harbour into the sea.

How many acres is there in the present harbour?—About 25 acres perhaps.

Would that be at all adequate for a harbour of refuge?—Yes, with the proposed extension, probably 40 to 50 acres, I apprehend it would be.

You propose to obtain 16 feet water?—You might go to any depth you pleased; but, there is an impossibility now of an entrance to Dover Harbour at times, because the present piers do not extend beyond low water mark, and therefore the accumulation of the beach blocks up the entrance to the harbour.

Many of the ships that require shelter and protection, large merchant ships, will require 20 feet, how would your harbour provide for those ships?—I quite admit it would not, but it would be extremely expensive to provide a harbour fit for them; for a ship requiring 20 feet water I think it would be altogether impracticable, and that according to the plan proposed, a ship of 20 feet would very probably strike in that harbour when there was a

Mr. *Henry Barrett.*

11th June, 1844.

heavy rolling sea. If you get out into the deep water of course you increase the expense and the length of time of construction.

You refer to the shallowness in Dover Bay as an objection, are you aware that at the distance of 175 yards there is 18 feet water?—Just in one place, but not all along the coast.

Are you aware that at 200 yards from the shore there is 20 feet water?—I was not.

Then you condemn the harbour without being aware of the facts?—I give a general opinion, there may be an exception in some part of the bay.

Are you aware that at 225 yards there is 30 feet water?—Yes, I have no doubt that may be a fact.

Should you think that with such a depth of water there is any apprehension of ships striking there?—I apprehend that with the great swell of the sea that would be the case sometimes when a ship trails in towards the shore.

How can the swell find its way in through a stone wall?—It will find its way in at the ship entrances, as it does now into the present harbour at Dover.

You say that all scouring water, whether natural or artificial, is injurious, and you think, generally speaking, the interior water should be passed out by some other than the ship's passage?—That is my opinion.

(*Mr. Walker.*) You know perfectly well the harbour of Yarmouth; is it your opinion that the water which now passes in at the harbour mouth, and goes up through the town, and into the Breydon, should be passed out by some other than the ship channel?—I think so, and I assign my reason. I conceive the tidal water there passing out of Yarmouth Harbour is entirely the cause of Yarmouth Bar.

Supposing that to be the case, what is it that makes a channel at all between the town of Yarmouth and the sea? what is there but the water passing in and out daily that effects that?—The natural river which has existed from time immemorial.

Do you mean to say that it is the water of the Yare?—On the bed of the river, generally speaking, there is a deposit from the inner rivers, so that they are obliged to dredge the harbour frequently.

Do you suppose that the passage would remain, and the entrance would continue open, if it were not for the water passing in and out through it?—The flood would run as it does now, and ever has done; but, I apprehend, if there was not any ebb returned out the ship channel, the bar would fall away, as it did formerly, on a new channel being cut out to the sea, and that, if the cause of bars were removed the effects would cease.

Would you allow the water to enter by its present passage?—Yes.

But you would send it out by another passage?—Yes.

Your plan would be to let the flood tide pass in by one passage, and to let the Breydon empty itself by another passage?—Yes, I apprehend the effects of egress waters are the same throughout the world; wherever there is egress waters passing out I find there is a formation of bars or sands. We observe the sands in the ocean, whether the Goodwin or any other, if you get on them at low water they are quite loose and quick, and you sink down some inches. It might be supposed that the impinging billows and the force of the tides would scatter them, but the original cause of the formation of the sands being constantly in operation each tide, the body is kept up and remains although the form may be altered.

Referring again to Dover, if a breakwater harbour were to be constructed there, with an outer wall, in 38 to 40 feet at low water spring tides, and having the depth of water before described within, do you think that would be sufficient as a harbour of refuge for any vessels?—I cannot offer any objection to it, provided there should be that depth of water, at a fair cable's length from the walls for such a vessel, but then there will be an accumulation take place within the harbour between the walls and the shore, which will probably amount to 18 inches per annum.

Why do you suppose it will be to that amount?—Because we have ascertained that it is to that amount in passing along the coast wherever it is let into a basin, and the water becomes quiescent. The late Mr. Smeaton ascertained that, at Ramsgate, 60 years ago, whether the space enclosed be large or small the accumulation on the bed of the ocean will amount to that annually over the entire bed of the basin or harbour.

You mean to say that in all harbours this deposit takes place?—Yes, where the bed of the sea is susceptible of being removed by the tidal waters.

(*Chairman.*) Do you not think that by paying attention to the bottom of the harbour with a dredging vessel, or a harrowing machine, it might be kept clear?—The harrowing the bottom would merely set it loose, just like shaking sand in a decanter, then it would be carried to and fro, and fall wherever the impetus ceased to operate, and which would be at the proposed entrances of the harbour, and so form bars. The only thing that could be done would be to dredge it, then it comes to a question of expense, but the dredging could only be done in fine weather.

Seeing the plan now before you, and the large space, even by the smallest of those plans, proposed to be enclosed, do you still retain the opinion that anything which should be done to the present harbour of Dover could form it into a port of refuge, adequate to the reception of the ships, contemplated under any one of those plans?—I think it would answer the purpose, except for the largest class of ships, and I fear if an exterior harbour were provided for them it would not remain so, from the impossibility of preventing the decrease of water.

Are you aware that the smaller plan includes 450 acres?—Yes, and the larger the harbour the greater the difficulty of dredging.

You would enclose only 25 acres?—Yes.

For what number of vessels should you consider yourself as providing accommodation?—I should expect there never would be more than 100 sail of vessels there.

The accommodation required for the trade of the country would go far beyond 100 sail. In Ramsgate Harbour alone there have been 370 sail at one time?—That has been the case, but all the vessels going down channel would not put into Dover, some would go under Dungeness, others to the Downs, and others to Ramsgate.

Will not the harbour you propose be liable to fill up in time, as you suppose that the larger would be?—Then they must have the dredging machine often as it may be required, but the quantity of deposit would be comparatively small, and the dredge might work in all weathers.

The dredging is in proportion to the accommodation afforded?—Yes, of course.

You consider, as may be inferred from your petition to the House of Commons, that civil engineers are not persons competent to deal with the formation of harbours of refuge?—That is a most delicate question to deal with, but, with much submission, may I beg to state that it is not only my opinion, but it is the opinion of other persons, that the science of harbour making requires a very considerable degree of nautical and practical knowledge, before any person can be competent to give an opinion as to how piers and harbours should be constructed; and particularly their entrance, so as to receive the force of the impinging billows with as little effect as possible, and with but little resistance to the tides passing along the coast. These matters ought to engage the attention of the engineer who presumes to plan or construct harbours, but generally speaking these gentlemen have been at fault. We have obvious proofs that the engineers have been incorrect. If we take the case of Dover Harbour, for with all which has been done or expended there, the entrance is not deeper than it was in the reign of Queen Elizabeth, in fact, the depth is less than it was at that time, although there have been several entrances made, and attempts to improve it, at an enormous cost.

What nautical engineer can you name who is, in your opinion, the person to be intrusted with such a commission?—I would not take the liberty of naming any one. In the Report of the Committee of the House of Commons on Dover Harbour in 1836, the Honourable Commissioners will find Captain Boxer's, R. N., opinion, and the opinion of pilots on this subject.

Will you have the goodness to state what was your object in presenting your petition to the House of Commons?—My object was to be heard upon this subject, and to show that the principle of the scouring power was generally injurious, and never beneficial. The Honourable Commissioners are aware of the effect produced on Lowestoft Harbour by the scouring power. May I beg leave to direct the attention of the Commissioners to the proposed harbour at Foreness, the mouth of which, or its entrance, is to be at the north-west side. Vessels generally part from their anchors and cables in the Downs; with the wind from the south-west, and with a lee or flood tide, when they come up to the North Foreland, supposing the ebb tide to be down, how is it possible for a ship in a heavy gale of wind and a dark night to fetch up to the entrance and get in? therefore she would be driven into the North Sea in a perilous condition.

What would there be to prevent a ship breaking adrift in the manner you have described, anchoring under the lee of this harbour in smooth water?—I am assuming that she has lost her cables and anchors; but let us suppose that a ship had entered this proposed harbour, and a gale of wind from the north round to the east, it would be impossible for a ship to get out, although these winds would be fair to proceed down channel.

You say you are opposed to the construction of a harbour of refuge by running a breakwater into the sea?—Yes.

And that you would, in every case, improve a tidal harbour?—Not without some exception. My attention may be directed to such a place as Ramsgate, where there is no means of doing that, or forming an entrance harbour, without cutting down the chalk cliff.

At Dover you would prefer enlarging the harbour?—Yes.

How would you do that to the extent of providing for the accommodation of 300 or 400 vessels?—I quite admit that, if the object is to provide for the accommodation of 300 or 400 vessels, my plan would not be sufficient, unless Dover Harbour could be extended so as to comprise an area of 50 to 60 acres.

At Dungeness, how should you proceed to construct a harbour of refuge; by any inland construction or excavation?—This is what I propose (*producing a plan*).

This plan was proposed some years ago, was it not?—Yes; I think in the year 1837, by myself.

Here is a large quadrangular basin; how large is that?—I believe I proposed it to be sufficiently large to contain 150 sail of vessels, together with the entrances to the basin, where vessels might be moored.

By what process do you propose to keep this clear from shingle?—I believe the piers would be extended into deep water, where no shingle would accumulate; for if you carry out your piers where the sea does not break, so as to disturb the bed of the sea, we do not find the shingle moves.

To what extent should you have to carry your piers out to get that accommodation?—I cannot remember exactly.

Do not you suppose this is an engineering work on which the civil engineers of the country may be competent to form a judgment?—I apprehend, in carrying out these works, civil engineers must be called in, but not in the planning.

They would be necessary in the execution, but not in the planning?—Just so.

Did you ever attend any committee about this harbour?—I did so.

When was that?—I think it was in 1837, and Sir George Cockburn was in the chair.

Mr. *Henry Barrett.*

11th June, 1844.

Do you think that a strong westerly wind in this narrow passage (*pointing to the plan of Dungeness Harbour*) would not be objectionable?—That was one of our reasons for having another passage; supposing the sea to run very heavy from the west, a vessel could go round to the other side.

How could she possibly do that with a gale of wind?—She might anchor under the East Ness Point; but I do not admit that there would be so much sea as to prevent any vessel running in at the west entrance; but if there was she would be under the weather shore by going round.

Then it would not be a harbour of refuge, as she could not always make it available?—Not on the weather side; she might enter at all times on the lee side.

With your object of constructing a harbour of refuge, how should you proceed off Eastbourne? there is no tidal harbour there?—I beg to say I should never propose such a harbour. Ships lying under Beachy Head, and the wind suddenly changing round to the eastward, it would be impossible to protect them, or get out and round Beachy Head. I think if there were a good harbour at Dover, and another at Dungeness, and another in the Downs, that is all which is required between the Downs and Portsmouth.

What is your estimate for a harbour at Dungeness?—I think 170,000*l.* We have an opportunity of calculating, with some degree of accuracy, what it will cost. We know what the excavation will cost, and what the piers will about cost each square foot; and, therefore, we can make the calculation with some precision.

How can you provide against the entrances filling up with a large quantity of shingle travelling round?—I know there is an annual increase of the point. I am of opinion that if those piers were carried into deep water the shingle would accumulate on the beach, near the piers, probably more than it does at present, and that it would fall on and form on the flood side a right angle of shingle; but it would only extend to a small distance from the shore along the piers.

Your piers would act as groins on each side?—Precisely so; if they were carried out in the way proposed I think there would be no shingle brought to the pier-head, where the current would be exceedingly strong; but suppose it did reach to the pier-head, it would be carried away, for there would be no in-draught to take it in between the piers.

Have you any proposal to offer to the Commissioners as to what, in your opinion, would be the best position in which to construct an asylum harbour in the channel, on the coast between the mouth of the Thames and Portsmouth, capable of receiving men-of-war of the first class and the largest description of merchant ships of an outward and homeward fleet?—I have no such suggestion to offer.

You were understood to say that you had an objection generally to constructing a harbour in the sea?—I have, for the reasons I have assigned.

Have you any remedy to propose to prevent such deposits, which you believe to be taking place in all bays, and in the mouths of harbours generally?—If you separate the questions I will answer them. I know of no means to prevent the deposit in bays; but as to harbours, I contend that bars are the effect of some cause; and if the cause is not in operation, no accumulation can take place.

Have you any remedy to propose?—My remedy is to remove the cause, as I have before said.

Be good enough to state what in your opinion is the cause?—I believe it is, as I have already stated, the result of the egress waters and the confluent action of the sea, just as we see at London Bridge, where a great deposit takes place during the ebbing tides.

As you have only 12 feet at low water in the harbour you propose at Dungeness, what use is to be made of this harbour?—We could produce more water through it, if we carried our piers further out; but it has been considered that that would be sufficient.

If you had a greater depth of water at the entrance, should you propose to have a greater depth all the way up?—Yes, certainly, the same in the basin as at the pier ends.

What is your width between your piers?—I think, as far as my recollection goes, we intended to have it about 100 feet.

Do you think a ship, running in in a gale of wind, with a heavy sea, could steer in conveniently with 100 feet passage?—I should have no doubt of it.

You say you are acquainted with the locality of Dover and the Channel in general; do you consider that, by running out a pier in deep water from Cheeseman's Head and excavating the inner harbour, sufficient space might be obtained to give shelter afloat to the packets on that station, and to a squadron of war steamers?—I think all those objects might be obtained by my proposal.

Do you think that, if such a pier were run from Cheeseman's Head into deep water, the shingle would be thrown so far out, and so deposit as to give no further trouble there?—Yes; but I should not extend my pier from Cheeseman's Head, but from the present pier, or a few feet westward from it.

You think that would stop the shingle?—I am quite sure that, if the piers were carried into deep water, the shingle would never find its way round them, or make a lodgement there. I think a great error has prevailed for some years on the subject of the travelling of the shingle among the Dover people; they have supposed that the shingle all came from the westward. I believe this to be a fallacy. I think, on the contrary, it alternately accumulates up, and is again drawn off the beach. With a heavy south-west wind the floods come up and accumulate the shingle along the coast; and then, when the wind changes, the ebb tide pulls it back again into the sea, from whence it had been dislodged; so that it does not travel from the westward in the way it has been stated.

3344. If you have nine months westerly wind and only three months easterly wind, does not

that come pretty much to the same?—Although there is a prevalence of westerly winds, the shingle does not increase on the beach, except in extraordinary tides. That there has been, during past years, an increase of beach on the Kentish coast is obvious, for Dover and Deal are both situate on what may be called a modern accumulation; and the coast of Great Yarmouth and other places have undergone a similar change. If 25,000*l.* were immediately applied towards the extension of Dover pier, the beneficial effects would be seen ere the present year passed away. But the Dover people seem to think that all the shingle comes from Dungeness, or the westward. Mr. *Henry Barrett.* 11th June, 1844.

[*The Witness withdrew.*]

Captain Sir *Samuel Brown*, R.N., K.H., examined.

(*Chairman.*) You are the constructor of the Brighton Pier, of suspension bridges, and the originator of chain cables?—Yes. Sir *Samuel Brown*, R.N., K.H.

Have the goodness to state what is your proposition?—I have not come prepared with any specific proposition; I attend here in consequence of a note stating that the Commissioners wished to see me to-day at two o'clock; but I shall be happy to avail myself of this occasion to state the objects I have in view. First in order, because the subject has engaged my earliest attention, I would recommend that the construction of stone towers on insulated rocks for the purposes of lighthouses should be discontinued, and that wherever sea-lights are required on similar situations, that bronze columnal lighthouses of the same altitude should be erected, adapted for the reception of lights of the first quality, and affording ample accommodation for the light-keeper's stores and provisions; which could in most instances be supplied for one-eighth part of the expense, and in one-fifth part of the time; for example, the Pollard Rock, one of the seven stones, the Cunnybeg Rock, near the Saltees, and various others. The Skerry Lighthouse, the last, now nearly completed, in point of magnitude and expense throw all other works of that description into the shade; it contains nearly times more solid masonry than the Eddystone tower, and it is admitted by Mr. Allan Stephenson, under whose directions it was executed, to have cost 95,000*l.*; but I believe that this estimate only embraces the tower itself, and that they have not charged that work with the refuge harbour on the island of Taree, without which it could not have been attempted; and I have not the smallest doubt that, by the time it is entirely completed, that it will have cost 110,000*l.*; whereas the bronze columnal light, in every point of view superior, could have been erected for 10,000*l.* to 12,000*l.*, and completed in four or five months. In point of fact, I made a specific offer to construct it for that sum, and to guarantee its stability for three years. I may just observe, that the expedition with which the bronze column can be completed is even of more importance than the immense saving of expense; for it has been ascertained that several most deplorable and fatal shipwrecks occurred while the works were in progress, which would have been prevented by the more speedy exhibition of the light.

Have you ever made any statement of this to the Trinity House?—No, except through the medium of my pamphlet for the proposition to which I have alluded to; the Northern Light Commissioners in Edinburgh, I believe, are entirely independent of the Trinity Board in London.

Have you ever given much thought to the construction of breakwaters?—Yes: the subject of fixed and floating breakwaters has for a considerable time engaged my attention, and I have prepared models of both those plans; the fixed breakwater was too large to bring it here to exhibit on so short a notice, but I have brought a sketch of it here, which will give a very imperfect idea of it. I have, however, brought the model of the floating breakwater (*producing it*). In point of principle there is no material difference between my plan and Captain Tayler's. In the construction I employ bronze, which is imperishable, instead of timber, which, besides the decay of the material, is liable to be destroyed by worms or marine insects.

What is the inside?—Turf packed between the bars would answer the purpose; but it is not very material whether it is filled with turf or cork.

Does not the turf wash away?—No; the openings of the frame are so small it would not escape.

How is it floated?—It is floated by the cylinder, which displaces the necessary quantity of water to give it the desired buoyancy.

What are the bars made of?—Of bronze; they are supposed to be six inches wide and a quarter of an inch thick.

Do you find bronze better than iron?—Yes; but not in a mechanical point of view. If we could depend upon this new chemical proposition of galvanised iron it would answer quite as well, and of course be a great deal cheaper; but we have not had sufficient experience of its durability. In the construction of a fixed breakwater, it might be desirable to use the galvanised bars in one section, in order to prove its efficacy.

By bronze do you mean a mixture of copper and tin?—Yes.

What is the difference of price between bronze and iron?—Bronze for a lighthouse or breakwater would cost about 100*l.* per ton; the galvanised iron, I should think, would be about 40*l.*

What is your plan for a fixed breakwater?—I can give a very imperfect idea of that by perspective drawing. This is supposed to be a perspective view of it (*producing it.*) The front elevation opposed to the sea is 20 feet in height 2 feet above low-water mark; the back or inner elevation is 54 feet, being 10 feet above high-water mark. The lower part of the

Sir *Samuel Brown*, R.N., K.H.

11th June, 1844.

fixed breakwater may be either open work, to allow the passage of the shingle or sand, or, if it is desirable, it can be made close to intercept it, so that the accumulation may form the base of the breakwater.

Under what circumstances can it be desirable that the shingle should pass through?—The obstruction to the natural diffusion of the shingle, while it affords protection against the force of the sea in some places, proves most injurious, and indeed destructive, in others; for instance, the Black Rock Groyne at Brighton, which I believe is about 150 or nearly 200 feet in extent, has caused an accumulation of beach to a great height, and laid the adjoining ground bare to the chalk, which exposed the cliff to the violent surge of the waves, which caused an immense fall of the adjoining cliff.

What proportion of slope do you give to your breakwater?—Thirty to thirty-five degrees.

Is there any wood in the outside frame of your breakwater?—No; the whole interior, consisting of transverse and longitudinal bars, diagonal and upright shores or pillars, and other framing, is bronze.

Have you ever thought about a harbour in the neighbourhood of Beachy Head?—No; not, at least, so far as to enable me to form an opinion of its eligibility.

On which side do you think it is most desirable?—If it were possible to run it out from south-south-west to south-south-east, from Beachy Head; there would be good shelter on either side, according to the state of the wind. On the east side of Beachy Head, with the wind at south-west, it is quite smooth; and when the wind is easterly, occasionally may be seen a large fleet of vessels riding to the westward of the Head.

Do you mean in Seaford Bay?—I should have said Seaford Head.

When you have been contemplating building a breakwater, have you thought of any particular place?—There is hardly any part of the coast where I believe a breakwater could not be formed; but the situations where it would be most useful are, I should say, first, at the Brake Sand. I have heard it said that the Brake Sand has shifted, but I believe there is no change in the position of the main body; and what is considered shifting, I take to be an accumulation of sand thrown over the bank by prevailing north-east winds.

Does not the very fact of the accumulation of sand and mud in the anchorage show that it is not a fit place for a harbour?—If that fact is clearly ascertained, of course only small vessels could ride there; but, if I recollect right, there is still from five to six fathoms water inside of the Brake.

The expression in the public notice which the Trinity House have given to the world is, that the sand has shifted bodily in?—My opinion is merely speculative.

Do not you believe that sands do shift in that way?—I believe the Hasborough Sand has shifted, but we do not hear of the Goodwin Sands moving. I would not propose a breakwater in the part of the sand which is ascertained to be shifted.

What is the duration of iron under salt water?—I think that iron which is accessible every tide may be preserved by the common preservative of cleansing and painting.

Do you mean malleable iron?—Either.

With respect to cast iron; do you think it possible by the same means to prevent its being converted into plumbago?—The chemists differ about that.

Is there any way of preventing it?—No; there is no way of preventing it when it is constantly submerged in sea-water, unless the galvanic process is effectual.

Whose proposition is the galvanizing?—It is a Company; I do not recollect the firm.

Have you heard what progress they have made in galvanizing iron?—Some of the reports, I understand, have been very good indeed; but I may mention what Captain Wellbank, one of the elder brethren, a few days ago stated—that the buoys which are hooped with iron formerly became so corroded, and exuded a sort of yellow ochre, which spread and destroyed the distinguishing colour of the buoys, which was prevented by the galvanic process. Recurring to the subject of breakwaters, it may be an objection that the sand shifts, but there are many places which are free from this insuperable objection where breakwaters on my plan could be constructed with infinite advantage; and there is no place in the kingdom where it would be so easily effected, or of such great utility to the coasting trade, as the shoal called the Smithwick, in Bridlington Bay, which is three miles and a half in extent, and the depth of water on the ridge or centre of the shoal, which is rocky or hard ground, not more than 12 or 14 feet; for more than two miles and a half within which there is clear anchorage two or three miles in extent, which would contain at least 200 sail, the depth varying (*see Chart*) from five to seven fathoms.

What depth of water did you say there was on the roadstead?—From five to seven or eight fathoms.

Is it good holding ground?—Yes, excellent holding ground; and the shoal may be considered a breakwater half made, only requiring to be completed by the transportable breakwater.

You are speaking of building upon this sand; by what method would you do it?—The breakwater; I have been very imperfectly understood without inspecting the model. The form is nearly similar, but of greater dimensions, to rest on the ground, as the floating breakwater, and then the inner ledge of breakwater would be about 12 feet above high water spring tides.

Would you propose that of bronze?—Yes.

With a platform to work on it would form an inclined plane of 30 to 35 degrees, and this inclined plane would be filled in at given distances, after it was sunk, with oblong square blocks of granite, forming a series of ledges rising like steps one above the other.

Sir *Samuel Brown*, R.N., K.H.

11th June, 1844.

You have stated that Smithwick Sand forms a protection to the ships lying in the roadstead within it?—No; it can form no protection with the wind from the south-east in its present state, because, at high water, the sea rolls in over it without being much subdued.

When the wind is in the direction to cross the Smithwick Sand it forms a protection?—Only at low water; but it is a very good anchorage now with the wind from west-north-west to east-north-east, but with the wind from east to southward of east, it is no protection.

Does the Smithwick Sand form a protection at all?—Yes, it forms a protection at low water.

Does not it form a protection until half-flood?—It does.

What depth is there at low water?—Twelve feet for a very considerable extent.

What is the lift of the tide?—I presume from 18 to 20 feet.

Would it form a protection until there be a depth of 22 feet over it?—No; it forms very little protection; the sea would break over it at 22 feet, and of course there would be comparatively smooth water within the breakers, but at high water, when there was five fathoms over it, there would be no shelter.

If that be the case that the protection is formed by a sand which does not reach nearer than 12 feet of the surface of the water at low water, and which is 10 feet more at half-flood, do you think that a floating breakwater which only intercepts about 6 feet in depth of the surface of the sea, and allows all below to be perfectly open, would ever form that kind of protection which is desirable to a fleet of ships within it?—I should say that a floating breakwater is only applicable in deep water. It could not be laid down or moored on a shoal exposed to the effect of a heavy sea; it would strike the ground under such circumstances, as it would draw 10 or 12 feet, and be dashed to pieces: 6 fathoms on any exposed coast or bay is the least depth that could suit a floating breakwater.

The breakwater formed by the Smithwick Sand, which has 10 feet over it at low water, and 20 feet over it at half-flood, forms a breakwater by intercepting from the surface of the ground up to within 20 feet of low water?—Yes.

If you are going to moor a floating breakwater in deep water, do you not leave every part open to the sea except the surface, which is intercepted by your 6, or 8, or 10 feet of breakwater?—Yes; speaking in some degree from analogy, a boat will be under the lee of a frigate, sheltered from the heaviest sea, which may be considered as one length or section of a floating breakwater, which only requires to be extended to afford similar protection.

Is not that by cutting off the wave, but leaving the motion of the sea under the ship's keel just as it was?—No doubt there would be an undulation, a ground swell and lift, or onward motion. The crest of the wave being broken can never acquire fresh volume.

You state that the Brake is a breakwater at present?—Yes; during certain periods of the tide it must be.

How many feet is there over it at low water?—On reference to the chart there appears to be only 10 feet; in some parts the greatest depth required for establishing the breakwater would be three fathoms. There is upwards of two miles of this uniform depth in the best site for a breakwater.

But it forms a breakwater already?—Yes, and so do the Margate and many other sands, as long as the sea breaks over them. It was the observation of these natural causes which first gave rise to the idea of converting a sand-shoal into a permanent breakwater. There is not a sand-bank in the United Kingdom, excepting such as are known to be moveable, which may not, at a comparatively small expense, be rendered a most effectual breakwater. I have not the least doubt, though a floating breakwater would not afford such complete shelter as a fixed one, that many situations which cannot now be considered as roadsteads, might, by this means, be resorted to with perfect safety.

Cutting off the wave but leaving the rise and fall of the water as it is?—Yes; the best received theory is that the one half of the wave is above the ordinary level of the sea, and the other half below it: for instance, suppose we assume that waves are running 20 feet high, then what we term the hollow or trough of the sea is 10 feet below the smooth water level consequently the bottom or lower part of the structure would be, when lifted by the wave, on the same level as the trough of the sea, and the upper part would be on the same level or a few feet above the crest of the wave; and as we must presume that it is securely held in its place by the moorings, the obstruction must break down waves in succession.

Do you wish the Commissioners to understand from that that a floating breakwater of ten feet would completely cut off all the movement of the sea below that level?—These observations are principally applied to the narrow seas. I do not say that in the open sea it would, but that may be met by increasing the dimensions of the breakwater.

You will see that if that be correct, it is inconsistent with your remark on the Brake Sand forming a breakwater or protection, as the substance, either of the one or the other of those sands is not less than 10 or 12 feet below low water?—I have stated that it was impossible to lay down a floating breakwater in such situations; if it struck, it would, like a ship, be dashed to pieces; and what would prove fatal to the floating breakwater is the fundamental principle on which the system of fixed breakwaters is sustained.

(Mr. *Walker.*) I have put these questions to Sir Samuel Brown, considering that the navy is greatly indebted to him for his important invention of the chain cable, and that civil engineering is indebted to him for his invention of suspension bridges, which he has stated to me was first suggested by paying attention to a spider's web, which demonstrates the principle of the catenarian curve as evidently as by the extension of the strongest chains.

[*The Witness withdrew.*]

Adjourned till to-morrow at 12 o'clock.

Wednesday, June 12th, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *W. H. Smith.*

12th June, 1844.

Mr. *William Henry Smith,* examined.

(*Chairman.*) Where do you reside?—33, Fitzroy-street.

What is your profession?—Civil engineer.

How long have you been engaged in business as a civil engineer?—About 14 years. I do not mean to say all that time on my own account, but since I commenced.

Where have you been chiefly employed during that time?—I was first employed as one of the engineers in the construction of the St. Helen and Runcorn Gap Railway and Docks.

On what occasions have you been professionally employed?—I have been professionally employed on the Leeds and Manchester Railway, and on the Great Western Railway. I was one of the engineers of the latter upon the first length out of London, where I continued up to the opening of that portion of the line; and still more recently I was engineer to the proposed Portishead and Clifton stone breakwater pier and road.

You profess to have given your attention to floating breakwaters?—I do.

What is the description of breakwater that you propose?—From an inspection of the drawings and model, it will be seen that from the peculiar direction in which this breakwater floats, the force of the sea, instead of driving it below the surface in severe storms, would rather tend to raise it upwards, in proportion to the momentum of the wave, counteracted by the opposite tendency of the moorings. The comparative freedom from strain or injury is obtained by the peculiar manner in which this breakwater is moored. Instead of being unyieldingly anchored to the bottom of the sea, and thereby exposed to the full violence of the waves, it has a play of from 20 to 30 feet, to which extent it may for a time be driven by the sea in bad weather, but from which it gradually returns to its original position. This effect is produced by attaching to the middle of the mooring-chains a counteracting weight, which, in calm weather, or whilst in the valley of a wave, will rest at the bottom of the sea, but which, when the violence of the waves drives the breakwater towards the shore, rises with the mooring chains as they are drawn towards a straight line. By the rising of this weight the resistance offered by the breakwater increases in a tenfold proportion to the impetus of the waves, and, after overpowering their force, restores the breakwater to its original position. It is thus provided, as it were, with a spring-like action, which enables it to elude the direct shocks and momentum of the sea, and to return almost immediately to its former station. Although, as an individual, I have expressed the firmest confidence in my plans, having made calculations and practical experiments, all of which correspond, I should, nevertheless, were I to carry them out myself, test them in the severest manner. But supposing the possibility of the Government ordering their trial, the more prudent course recommended by Mr. Walker would probably be acted upon, viz., to apply them within and along the extent of such natural ridges as the Smithwick Sands, in Burlington Bay where he is of opinion they would afford protection at all times. Redcar is another situation, already partially formed by nature wherein an adaptation of this principle would be the means of making a harbour twenty times larger than Scarborough, proving an incalculable benefit to the eastern coast trade. But I most respectfully submit that, from the nearly average traffic around our coasts, there is an equal necessity at all points for harbours of refuge. I have evidence of a fleet of 50 ships being caught by a gale of wind at only 50 miles from one of these harbours, Sunderland (*Report of Committee of House of Commons, 3rd May,* 1836), and, being unable to beat in, nearly all were wrecked and lost. Now, from the enormous cost of stone breakwaters, a very limited number only can be formed, leaving unprotected hundreds of miles of coast; and, as the Duke of Wellington states, an enemy's steam-vessel would watch the ships up Channel, and seize them at the most unguarded points; whereas the cost of constructing and keeping in repair 20 floating breakwaters would not amount to so much as one of stone. They would, therefore, become very desirable adjuncts to stone, as forming intermediate stations solely for the purposes of refuge. They are certainly not in themselves calculated for batteries, unless the American floating shot-proof batteries, or Mitchell's improved screw-pile batteries, which have been so favourably received by the Ordnance, were attached to them. Indeed stone forts might, where required, be applied with equal facility; but this I should conceive quite unnecessary, as an enemy's fleet would find them no breastwork from which to fire upon the shipping or town within; on the contrary, fearing the broken and splintered timbers, they would give them a wide berth. I have brought with me models to illustrate it by a spring, showing the relative degrees in which the weights decrease; and I was surprised, when I tried the springs, to find their enormous extent of yielding quality. As the shock of the sea strikes this breakwater, it has a yielding action of about 10 or 20 feet, or from that to 30 feet to leeward. The principle of mooring is strictly analogous to that of a kite in the air—whichever way the tide swings, the blow upon this section will always be regular. I have found, in making a trial of my model on the coast, even without any balasting, which I propose, that immediately a wave struck the section, it crested upwards. The back frame is for no other purpose than to give a little additional strength. I con-

ceive that the plan, with interstices, or with open frame, would in either place be sufficient without any back; and in one instance I have simply braced my frame by iron rods from corner to corner. Mr. *W. H. Smith.* 12th June, 1844.

What is the scale of your model?—It is intended to be 60 feet long and 30 feet deep.

What are the cables made of?—The cables are made of iron rods about 10 feet long, running through square timbers, and, as a matter of course, attached to each end. These timbers will have the double strength, the longitudinal strength of the timber, and that of the rods combined, which will be more than treble as much as the ordinary cable that is used—from the weights upwards. In this portion I propose hollow tubular moorings, hermetically sealed. These are attached to the bridle chains, which are chains to the upper surface. The bridle chains are rods, and moored at the required end.

Have you ever been at sea?—Not as a mariner, but I have been at sea. I have had a great deal of experience in nautical matters.

Where have you been?—I have been a week at sea several times. I spent a great deal of my time on the coast of the Atlantic.

Have you ever been at sea in a gale of wind?—I have been at sea in a storm.

Your proposition goes to prevent the breaking of the sea within the harbour, but not the swell within it?—I have shown that I do not consider that there is a swell within it, I consider that it is impossible to have a swell where the particles of matter are all in opposition to each other.

Do you propose that your breakwater is to prevent any swell within the harbour?—The upper surface swell; but I never contemplated that it would create a perfectly smooth surface, but what is ordinarily termed by sailors smooth water.

What are the tubes for?—To give buoyancy, and thereby there is no drag whatever from underneath upon the section.

Are you acting for yourself, or in connexion with any other person?—In no way in connexion with any person.

You were understood to say, that you and Captain Tayler were acting together?—We are co-patentees in what is understood as Captain Tayler's patent in the original plan.

In what does your plan differ from his?—It is considered very materially to differ from his. The opinions of nautical men as to all other floating breakwaters, and at the time they were shown to the Committee of the House of Commons, the opinion of the Committee was, that they would break from their moorings. I had been studying the subject of moorings for three years; and it occurred to me, that if I could get a yielding principle it would be much better. Of course the great object that was required was the giving to it a steady pressure. A cable depending simply on its catenary formation would have a tendency to pull the section down in proportion as it was tightened. I have heard nautical men state, that ships in a gale of wind, riding at anchor in a very heavy pressure, upon some occasions have been known to go down by the bows head-foremost, under the enormous pull upon the bows; there is always a very heavy pressure.

You said that you are co-patentee with Captain Tayler; are you aware of the resolution of the Select Committee of the House of Commons on Shipwrecks, after they had heard all that Captain Tayler had to say?—I believe I am.

It says this:—"To the various plans and models of floating breakwaters the Committee have devoted their best attention; and considering the expense of constructing and maintaining them in repair compared with the durability of solid breakwaters (which should be calculated to endure for ages), your Committee are of opinion, that whatever may be decided on as to the formation of harbours of refuge, such national works should possess the most perfect solidity, to resist the force of any sea, afford shelter to the trade, and—a great and essential advantage—of having powerful batteries erected on them." You do not profess to have batteries erected on your breakwater?—I will, with permission, go into that subject in a short time. A battery may be formed at each end of this breakwater, as well as at each end of a stone breakwater; either a stone battery or a Mitchell's battery.

But it must be independent of the breakwater?—Quite independent of the breakwater.

Supposing from any accident, with all your precaution, the chain should part, or the mooring should part, the whole must be swept away to the destruction of all the vessels within it?—In the event of the cable breaking, the immediate effect of this would be to swing end on.

Then all vessels within reach of it would be struck by it?—There would be no vessel lying so close to it.

But at any rate, if such an accident did happen, even if the breakwater itself were not destroyed, it would let the sea in upon the vessels after having invited them in for shelter?—No, I cannot admit that, the front would only be 60 feet, and you would have five times 60 feet, opening to an ordinary breakwater.

Are you aware of the rapid destruction of wood by the worm?—Yes, I am; I have paid a very great deal of attention to the subject, as it has been one of the great points of dilapidation of wooden harbours, and has been one of the great objections that has been urged against them.

What do you calculate would be the duration of your wooden frame?—I take my data from a well-built merchant-vessel lasting fifty years; I calculate that this will last fifty years, but when prepared with a substance which is generally used by the Admiralty,

Mr. *W. H. Smith.*

12th June, 1844.

the marine insoluble glue, I do believe, as a professional man, it would last a great deal longer.

Have you any proof of this insoluble glue preserving wood from the action of salt water?—I have.

Where has it been tried?—It has been tried at Portsmouth, under the command of the Port Admiral, and since confirmed before it was applied to the Victoria and Albert steam-ship; I state this upon the authority of the parties who are the patentees at Limehouse. I saw a block of wood that was sent up to me to examine as a specimen.

Are you aware that the piles at Brighton do not last ten years?—Yes, I am.

What is the date of the Report from Mr. Walker?—The 27th of June, 1842.

You cited that Report as evidence in some degree favourable to a floating breakwater?—As far as being a partial means of breaking up the operation of the sea.

Are you aware that in that letter Mr. Walker expresses an opinion very unfavourable to a floating breakwater in such situations as Plymouth and Dover, and that he thought inventors were risking the character of their schemes by desiring to press them at once into such a service?—Yes, and it will be seen from what I have stated, that I approve entirely of what Mr. Walker has recommended; I remarked that the more prudent course would be, to try them behind such sands as the Smithwick, in the event of the Government adopting them. But with respect to my breakwater, which was not in existence with its improvements when Mr. Walker gave that Report, I should not hesitate to say that it might with success be placed upon any part of the coast, because the shock of the wave which would otherwise come upon it is transferred into a regular and steady pressure, therefore it becomes no more than the operation of a current.

Captain Brown, in a letter to the Commissioners, has stated that 14 inch piles in six years were reduced to 10 inches; are you aware of that fact?—I have had a great deal of conversation with him; I believe I have noticed them very closely myself, I have been under the Pier at Brighton in all weathers, I have seen the shock of the sea upon it; the timber receives no chemical preparation, and I am firmly of opinion that after a slight decay, the mechanical action alone will cause serious dilapidations to all fixed surfaces that are unyielding, upon the same principle that some trees will yield before the current of a storm; whereas the more fixed, though stronger, such as the oak, would be torn up by the operation of the element.

What are the defensive powers of this floating breakwater against hostile attack?—I conceive none whatever; I think they might be sunk by weights, in case of an enemy's fleet coming, in a couple of hours; but no enemy's fleet would run for shelter behind an unopen framework.

Then you would not recommend floating breakwaters for constructing harbours for offensive or defensive operations, or as a station for armed vessels of war in the event of hostilities?—For the protection of shipping I should propose the necessary fortification; unlike a stone breakwater, they do not present any breastwork, and therefore it would not be necessary to have those batteries; I simply propose this in such cases, as it might be applied behind the Smithwick Sands, or the Salt Scar in Redcar; and in such cases it would form a very desirable adjunct to stone breakwaters, as forming intermediate stations or harbours of refuge.

What defensive power would you give them?—The defensive power of the batteries; I conceive they are much more applicable than stone breakwaters for defence, because an enemy's fleet could not seek shelter behind them as they would behind a stone breakwater.

Would you have a floating battery?—No, the batteries at the ends would be upon the ordinary well-understood principles, either stone batteries or the batteries to which I believe the Duke of Wellington alludes when he speaks of Mitchell's Pile Batteries, which have been before the Board of Ordnance.

Have you any calculation of the durability of this fabric with the sea passing through it; being moored, the water gets wire-drawn through it. The water must pass through the fabric with great velocity, acting, as we know water does through an aperture, filing the timber away. Do you apprehend that the durability of this would be considerable under such circumstances?—I do.

What do you conceive to be the durability of a breakwater of this description?—I should say, at least 50 years.

You have stated that the action of the water upon the piles at Brighton has had a considerable effect in wearing them; would not the same action of the water take place upon this framework?—Not exactly, because I do not fully agree with the expression "filing," I conceive the rolling action of the globular particles of the water upon the surface cannot possibly be a filing, because we have the ships' sides exposed to the same action. I have stated that if I get this only to be as durable as a ship, it will answer the purpose; but I do not conceive the two cases are similar, for the fixed piles at Brighton receive an immediate shock because they are unyielding, and there is a breaking off of the particles where they rot.

Have you made any calculation of the expense?—I am prepared to give the prices of a section.

What is the expense of one section?—One section of 60 feet would cost 310*l.*, with everything complete; that would be when a number are constructed together. I would not attempt to put one section down alone for 1000*l.*

If you were called upon to put one section down, what would you charge?—I should think 1000*l.* at least, 1,500*l.* perhaps, for this reason, I should require steamers, and the same

steamers that I could employ to draw out and lay down the whole number would be required to lay down one. Mr. *W. H. Smith.* 12th June, 1844.

What do you conceive would be the durability of the moorings; how many years would they last?—I should say, seven years.

They would require renewal every seven years?—Yes, the whole of the moorings would not require renewal, simply the joints; I do not use a cable mooring.

It would require reparation?—Yes.

Do you apprehend that a very large ship coming against this breakwater would do it any injury?—No, I do not; but that is a nautical question. Sir S. Bentham was of opinion that "ships would cross in emergency without much injury;" he alluded to fixed moorings; how much more so with this yielding mooring.

You have said that in case of its being required, this floating breakwater might be sunk in the course of two hours; what means would you adopt for sinking it in so short a time?—I should propose to weight the moorings in such a manner that the section, being so near the centre of gravity of the water, it would drive it under; but I am of opinion that it would be needless.

If this great controversial question of stone *versus* floating breakwaters, were once decided, it would open an unbounded field for the investment of capital, not only in those harbours already established, but in numberless other well adapted localities which would eventually spring into existence as flourishing maritime towns, and thus render vast tracts of land now barren and unprofitable, a public benefit to the community at large, and a means of increased revenue to the Government.

[*The Witness withdrew.*]

Mr. *Peter Jeffries,* further examined. Mr. *Peter Jeffries.*

(*Chairman.*) You have been before the Commission before?—I have.

And you have desired to come again. For what purpose do you wish to appear?—Respecting a harbour of refuge; I was here before respecting the entrance to the present Dover Harbour and not as relating to a harbour of refuge.

Will you state what your plan is for a harbour of refuge?—If the Commissioners will allow me, I will refer to the plan which was laid before the Harbour Commission of Sir James Gordon in 1840, which plan I have got here (*producing the same*).

Are you going to speak of Dover?—Of Dover entirely. In the first place, the harbour of Dover as represented here is very inaccurate; it in no way resembles it.

You allude only to the inner harbour as represented by the lithographer?—Yes, I allude to this (*referring to the plan in the Report of the Commissioners of Harbours, in* 1840). I am of opinion, that the shingle, which will be brought up from the westward, would lodge against that wall and would travel after the wall to the proposed mouth, and I am fortified in that opinion by this Report of the Commissioners as to Dungeness; at page 7, it will there be found that the shingle at Dungeness has increased seaward, 118 yards in 47 years, which is seven feet and a half every year. The Report says, "The shore at the southern extremity is extremely steep and descends at once into deep water, but the whole promontory consists of a vast accumulation of shingle constantly increasing and extending seaward." It appears then that the shingle has travelled along there, where I have lain myself, under Dungeness many days when I have not been able to go down Channel, that is, the promontory of the whole bank of shingle has increased from the south-west side and also from the south-east side. So here in Dover Bay the shingle would keep increasing in the same way, but the wind could not have any power over it from the eastward to drive it away, and consequently it would lie quiescent behind that wall and go on increasing to the harbour's mouth, and I think this passage, as to Dungeness, is conclusive, that it would be so here. Now instead of having a harbour formed as this is, my proposition would be at Dover Harbour, that Cheeseman's Head should be shortened, that a channel should be excavated through the chalk rock on the east of the present harbour into deep water. I therefore would suggest, that the harbour should be formed of floating breakwaters on this plan, (*producing a plan,*) this is formed of wooden cylinders. I propose these to be 70 feet in length and 15 feet in diameter.

That is exclusive of the ends which are 10 feet each, making the whole length 95 feet?—Yes; these should be ranged as is represented upon this plan in two rows, the distance between each length in each row being about 100 feet.

And each length in the inner row being opposite to the opening in the outer row?—Yes; the one to cover the other.

How many would you require altogether of those separate breakwaters?—Supposing this chart to be correct, I put it from the Castle Jetty to come to the pier-head. I have put here about 36 cylinders.

All of wood?—Yes.

Are you aware of the mischief done by worm to wood upon the coast?—I do not apprehend that there is much mischief done to wood by the worms at Dover. Piles have been driven there repeatedly, and I could never see that there was much injury done to the piles there, but the wood could be so prepared by Mr. Payne's process that the worm would not touch it; there are several modes proposed for preserving wood.

Mr. *Peter Jeffries.*

12th June, 1844.

What proof have you that that process protects the wood?—I have no proof myself, but they state that it does. I believe there is no proof of it, but they could be either made of wood or of metal, and I think the metal could be so prepared that it would not oxydize.

Supposing you had 36 metal tubes have you any estimate of the expense?—No; I have not made an estimate of what the expense would be.

What do you suppose it would be?—Perhaps it would be 2500*l.* to 3000*l.* each.

If your plan were adopted of removing the pier from Cheeseman's Head, would not the shingle, which has been so inconvenient for years and centuries past, be increased rather than diminished?—Certainly not; I would refer to my former evidence to show, that that would not be the case. Besides my opinion is, that the shingle is local and does not travel as it is represented; that it is thrown on the beach and dragged off by the receding of the waves when the wind blows on the shore, and that it is driven along the shore when the wind blows from south to west, or from the north-east to south-east when the wind comes from these quarters, and may be said to be raking the coast, throwing the shingle upon the advance of the wave and drawing it down on the waves receding; that it is local, may be assumed from the fact, that it is abundant on the west side of Folkstone Bay, whilst on the east side of that bay it is not to be found, nor is it to be found at the eastward of Shakespear Cliff, whilst that round the south Foreland on Deal Beach is of totally a different character from that in Dover Bay; and I think that a very large portion of that shingle could be removed, so that there would be very little ill effect experienced from it afterwards. It could be either taken up in land or taken up and barged away. I think that the harbour could be made sufficiently large, or rather that the present harbour could be so enlarged as to afford shelter for ships of war, all that will be required.

Without a harbour in the bay?—I think without a harbour in the bay.

How long have you entertained this notion of floating breakwaters?—For several years.

How long do you think your cables would stand without being changed?—I inquired at the Trinity House how long those lasted upon the Goodwin Sands; but I do not recollect how long it was.

Were you examined before the Shipwreck Committee?—No, I was not; I was before Sir James Gordon's Commission in 1840, and my name appears in his Report.

[*The Witness withdrew.*]

Capt. Sir *S. Brown,* R.N.

Captain Sir *Samuel Brown,* R.N. re-examined.

(*Chairman.*) With reference to your examination of yesterday, be good enough to explain the model of the breakwater which you have now produced?—Of course I can only enter upon the general features of the plan; and upon some future occasion should be happy to describe more particularly the mode of construction.

Is it a floating breakwater?—No, it is a fixed breakwater, intended for the ridge of a sand-bank or shoal water on the coast, wherever it may be required. The front elevation which is opposed to the sea is 20 feet in height from the ground, and supposed to be in 18 feet low water, spring tides.

(*Lt.-Colonel Alderson.*) What is the scale of the model?—Half an inch to a foot; the back elevation is 42 feet above the ground, and would consequently be about 10 feet above high-water level, spring-tides.

What is the distance from the front to the back?—64 feet on the inclined plane, and the angle about 30 or 35 degrees. The length of the base is 100 feet?—It is a section of 100 feet, or any desired length.

What is the base?—56 feet. The frame is constructed of bronze plates or bars, six inches wide, and one-fourth of an inch thick. The sloping bars A are fixed on edge, and are riveted throughout to the vertical bearing bars B, transversely on the section, eight feet apart; and the longitudinal bars C, are riveted by flanges to the heads of the bearing bars, eight feet apart. D represents the diagonal bars, or shores, supporting the bearing bars. E F are waling pieces passing all round the structure. There are three lines of those waling pieces.

Are they the same size as the uprights?—The whole of the bars throughout the framing are of one uniform dimension. The oblique bars are strong trusses, to prevent the frame from warping or twisting, passing from corner to corner. There will be a series of those trusses throughout the interior and the bottom of the frame, which are not visible in the model. The bottom of the frame will be constructed of transverse and longitudinal bars, to which the vertical bearing bars, and the diagonal shores will be riveted. There will also be various horizontal trusses to stiffen the bottom. G G are blocks of granite, 15 inches deep and 6 inches thick, fitted in edgeways between the heads of the bearing piles, to form the upper course of the breakwater.

How are they fitted in?—They are notched into the edges of the sloping bars, and corresponding holes being cut in the ends of the stones, and the longitudinal bars; they will be further secured by copper bolts, H H, on blocks of the same dimensions, resting on the second tier of sloping bars; and I I are the third or lower courses which becomes successively breakwaters according to the state of the tide; K is a gangway or foot-path of granite (which would be railed in) extending to the whole length of the breakwater, which would be accessible at all times of the tide by means of steps or ladders between the inner bearing bars. A sufficient number of iron or copper cylinders or tanks are proposed to be attached to both fronts, and to the ends, to displace a sufficient quantity of water to float the section to its destination where

Capt. Sir *S. Brown*, R.N.

12th June, 1844.

it will be moored to buoys till the tide ebbs, when the structure will take the ground, and the cylinders be disengaged by stop-ropes or chains. It is to be observed that the granite blocks will all have been fitted and numbered to their respective compartments, and there will be no difficulty or loss of time in replacing them when they are conveyed to the spot M. On the left side is an inclined plane, formed of cork, representing the lower tier of the breakwater. It may be made either of cork, fascines, or other substance.

Do you mean that either may be used?—Yes, any durable substance that will resist the concussion of the sea will answer, but granite, on account of its strength and specific gravity, is preferable. The compartments on the right-hand side of the model contains two courses or layers of these fascines, saturated in coal tar; these fascines placed in ledge rows like steps, would form as effectual a breakwater as any solid material, and would be cheaper than any other filling-in; indeed the employ of these materials, being equally good in principle, becomes a question of comparative cost and durability.

If the fascines, cork, or other substance, were used, the granite would not be required?—Certainly not. I will now beg to state that the weight of the bronze frame to complete 100 feet, being a section or length of the breakwater, would be 35 tons. The cost 100*l.* per ton, viz. 3,500*l.* for each section. The granite ledges, 1,800 running feet, 6 inches by 15 wide, at 2*s.* per lineal foot 180*l.*, together 3,680*l.*

Is that all the estimate?—That is all the prime cost of the section; to which should be added the expense of transporting it to its destination—

	£.
Fixing the ledges of granite	100
Superintendence and Contractor's profit	500
Brought over	3680
Total expense constructing and laying down one section or length of 100 feet	4280

consequently a nautical mile and a half of the proposed breakwater on Dover Bay, averaging 30 feet at the outer front consisting of 90 lengths, would cost 376,300*l.*, and occupy about 18 months to two years in the execution.

(*Chairman.*) Have you any particular place in view in proposing this plan?—I have in my mind the Brake; since I made that section, I have heard that the sand has shifted, but I cannot believe it possible that any change in the position of the main body of the shoal has taken place that would affect the stability of the breakwater. There may have been some new deposit, or partial shifting of the edge of the bank, which has altered the relative distance of former soundings.

Provided the sand is known to have shifted, should you feel confident in undertaking the work?—No; it would be extremely injudicious to attempt to place the breakwater where the sand is known to have shifted.

Do you think any slight erection would tend to fix it where it is?—No; if the whole bed of the sand has shifted, it must all go together.

Do you think a sand that is half a mile wide and three miles long will all shift together?—I think it must be a mistake.

Are you aware that the Trinity House have published a public notice to the world that the sand had shifted half a mile in towards the shore?—I am not aware of it; but under such authority I would not recommend it to be constructed upon the Brake, which is much to be regretted, because there are few situations where a breakwater would afford better protection to the general trade of the country.

Supposing there was water there, what would you say?—I would say that the proposed breakwater on the ridge of the Brake to the extent of a mile and a half would form an asylum roadstead sheltered from every wind.

Do you think the channels could be deepened to the northward?—I should think not. The continual process of dredging would clear it away no doubt; but if it is sand, I apprehend it would soon fill up. With respect to Dover Bay, it does not appear that there are any difference in the sounding that can be defined as a sand-bank; but there is shoal water and a gradual increase of depth to a considerable extent from the beach, well adapted for the proposed breakwater, commencing at 4 or 5 feet low water, which would leave a passage for boats, and larger vessels as the tide flowed; and it might be carried out from this commencement in the direction most eligible for the purpose to the depth of 30 feet at low water.

What would you say of a depth of 42 feet?—It is practicable, but it would not be the most advantageous situation. If greater depth than 30 feet low water was required, I would propose to extend it by a few sections of a floating breakwater.

How would you fix the blocks of granite?—I would drill holes through the ends, and rivet them to the bronze plate.

Have you anything further to state?—I should observe that, independently of the important advantages of the proposed system, abstractedly considered, is the facility and expedition with which it can be carried into effect. For example, I should consider it perfectly practicable, with suitable modifications, to construct a breakwater according to the plan which I have but inadequately described in Dover Bay, to cover the harbour. If an extension in the required direction is one and a half mile nautical, it would require 90 sections, the whole of which could be laid down on skids, and launched from the beach.

How long would you be in completing a mile and a half of your breakwater?—As I have maturely considered the system in all its bearings, and being in possession of ample means, I would undertake to complete the work within two years.

Capt. Sir *S. Brown*, R.N.

12th June, 1844.

In answering that question do you refer to a shoal water breakwater, or do you refer to a deep water breakwater?—I refer to a breakwater of the depth I have stated, according to the model, on any suitable situation.

You do not propose, in your breakwater, to work at a greater depth than 30 feet?—30 feet at low water. I think it would be perfectly practicable and equally efficient as in shoaler water.

You would not undertake it at a greater depth than that?—I do not exactly say that; it would, no doubt, require greater strength of materials. I think it is possible, but I have not given that subject mature consideration.

What would be the difficulty in building it in six fathoms as well as five?—My present view of the system is that there would be no difficulty; but I would reserve a decided opinion till I have given the subject further consideration.

Supposing the depth of water at the place where your breakwater was to be sunk to be five fathoms at low water, and the rise of the tide to be 17 feet, what would you make the height of what you call the sea front?—The front elevation should be 32 feet 2 inches; and for the back elevation you should just add the highwater mark to that.

The width of your frame, and the length of it, would still be the same?—No. If you require a greater height you must have a greater area for the base, and inclined plane or artificial beach should be at least 80 feet, and the base 70 feet; but the length would remain the same.

Do you think you could do a mile and a half in five fathoms water, according to that increased section, in 15 months?—I should require some extension of time. The model represents the front of the breakwater 20 feet; there is no difficulty in adopting it for a depth of five fathoms at low water, but the work being upon a greater scale, it would require a proportional extension of time and increase of means, which, however, would approximate with the foregoing statement.

[*The Witness withdrew.*]

Mr. *John Mitchell.*

Mr. *John Mitchell,* examined.

(*Chairman.*) What is your profession?—I am an engineer.

Where do you reside?—At Belfast.

What proposal have you to make to the Commissioners?—I have brought with me a model of a battery proposed for the Goodwin or the Margate Sands *(the same being produced.)*

You wish to construct it on piles?—Yes, malleable iron piles.

To what depth do your piles go into the sand?—In that model they are shown 30 feet.

Have you ever bored the sand?—No, not the Goodwin, but I have no doubt from what I have heard of it, and from my long experience in putting screws into all sorts of sand, that we could sink the screw-piles to the depth of 30 feet.

Are you aware that in trying to bore they had not got below seven feet and a-half, and that they broke their instruments in trying to bore deeper?—I did not know that, but I think it would be easy to bore to a much greater depth than that; I think I could do it. My father prepared this model, in consequence of a suggestion when he was examined before the Shipwrecks Committee.

Will you read your own account of your invention?—

The same was read as follows:—

"*Description and Sketch of a Patent Screw-Pile Battery and Light-House, proposed to be placed on a Sub-Marine Sand-Bank. By Alexander Mitchell and Son, Engineers.*

"The annexed sketch is intended to represent, in perspective, a screw-pile battery and light house, constructed entirely of malleable iron, and having its screw-pile foundation firmly planted in a bank beneath the sea.

"The principle of such foundations has already been well tested both on the east and west coast of England; off the shores of which have been erected screw-pile light-houses, that have now withstood the storms of several winters, without exhibiting the slightest symptom of insecurity or decay.

"The stability of such structures depends on two causes:—First, the firm hold which the broad screw takes of the ground, by being forced far beneath its surface; and, secondly, the solid part of the building being placed above the reach of the highest sea, no broad surface is opposed to the free passage of the waves, consequently the structure is not affected by them.

"The first foundation of this description was fixed in the Maplin Sands by us in the summer of 1838, by order of the Honcurable the Corporation of the Trinity House of Deptford and Stroud, at the recommendation of their engineer, James Walker, Esq., F.R.S., and president of the Society of Civil Engineers, who has since erected on it the Maplin Light-house; and though it stands upon a bank of loose sand, many miles from the nearest coast, and exposed to the swell from the German Ocean, yet it is as stable and likely to endure as if based upon a rock.

"The foundation consists of nine spiral flanches, each of four feet diameter, keyed on the foot of as many wrought-iron piles; these were screwed into the bank to the depth of 22 feet, and, from the nature of the ground, might have been sunk to a much greater depth had it been considered necessary. This house was first lighted on the 10th February, 1841.

Mr. *John Mitchell.*

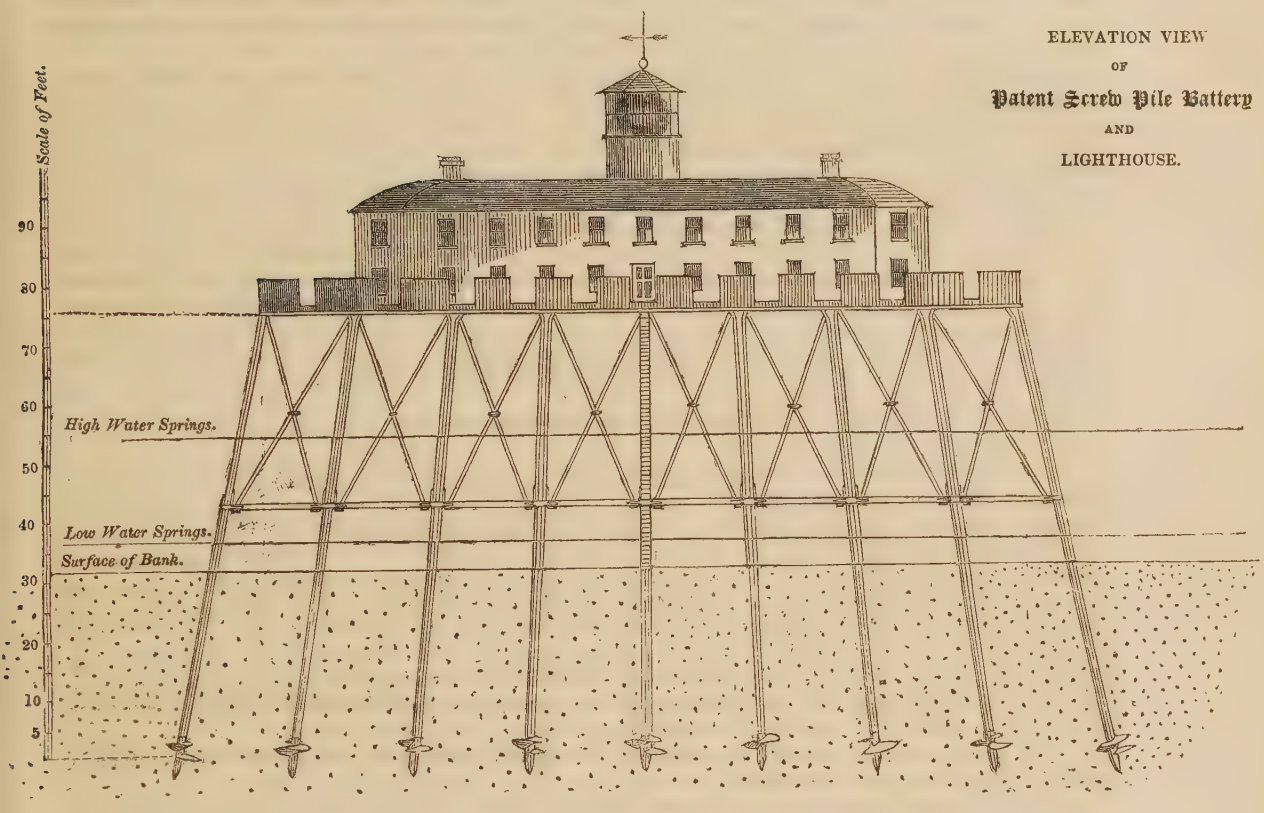
12th June, 1844.

" But the first light-house of this or, indeed of any description, so far as we are aware, that has ever been based on a sub-marine sand-bank, was erected entirely by us, after our own design, in the winter of 1839, at the entrance of the sea reach leading to the town of Fleetwood-on-Wyre.

" This house is now standing nearly four years, having been first lighted on the 6th June, 1840, and, though the material used in its construction is principally wood, a little paint is all that has been required to keep it in perfect condition since the time of its erection, although exposed on the north and west to the swell of the open sea, the tide rising on the columns upwards of 30 feet.

" We have thought it necessary to enter into the above details, for the purpose of showing with what perfect security many descriptions of work may be placed on sub-marine sand-banks by means of screw-piles; but our attention was especially directed to the subject in consequence of some observations which fell incidentally from his Grace the Duke of Wellington, as Lord Warden of the Cinque Ports, when giving evidence before the Shipwreck Committee of the House of Commons.

ELEVATION VIEW
OF
Patent Screw Pile Battery
AND
LIGHTHOUSE.



Mr. *John Mitchell.*

12th June, 1844. *Extract from the Evidence of His Grace the Duke of Wellington, taken before the Select Committee on Shipwrecks.*

"5264. CHAIRMAN.—The attention of the Committee has been directed to the subject of a harbour of safety between Portsmouth and the Thames; will your Grace have the goodness to state your opinion as to the necessity for the erection of a new harbour?"—'I have no doubt about it. I entertain no doubt that it is absolutely necessary. There is now no security between Portsmouth and the Downs. Dover Roads is a very secure place, in the period of a northerly or easterly wind; but there is no security at other times; but, on the contrary, it is a very dangerous place in a wind from the south-west. They can run for the Downs; but there is no great ease in the Downs; certainly, there is no security in Dover, except from warlike attempts. But I should say that, considering the want of protection from the weather, and from military attacks in the Channel, the trade of the port of London will be in a very precarious situation, and will be a very losing one, in a variety of ways, in time of war, if something is not done beforehand—if some precautions are not taken. Steam-power, in moving ships, has made such progress at present, as that it must have a most material effect in maritime warfare (I use the word maritime warfare in contradistinction to naval warfare) in all future times. If anybody will just consider the advantage the French coast enjoys over the coast of this country, in observation of what is passing at sea; that is, to the southward, they have the sun in their backs; they see everything quite clear; and it is possible, from the coast of France, to calculate to a moment at what period a vessel coming up Channel will arrive at particular points; and they may be in readiness to seize her, at any point which may happen to be unguarded, supposing the vessel to be without convoy, and supposing that there should be no naval means at that point to take care of her. I should say that the trade of the port of London would labour under a great disadvantage if it were found that every vessel coming up from Portsmouth was obliged to come up in a convoy; that she should be shut up unless there were a convoy; and there are no means of providing for that safety except by ports; not one only, but there ought to be, I should say, at least two between the Downs and Portsmouth. I should say one about Dungeness, and another, possibly, at Dover. I have given a good deal of reflection to it, and have thought of it a long while, and that is the conclusion to which I have come; and it is a rational conclusion, for it is founded on what the state of the commerce of this port (which is the great port of the country) will be, by-and-bye, if something is not done.'

"5265. Sir *Charles Napier.*—Is your Grace aware that there is a good bay in the Goodwin Sands, called Trinity Bay?—'I have heard that; but I have never been off to it.'

"5266. Your Grace states that there should be two harbours of refuge, one at Dungeness and another at Dover. Generally speaking, the trade coming from London, bound westward, may get into the Downs, but be able to get no further than the Downs, and may never be able to make the port of Dover; would it not therefore be better if the harbour of refuge was somewhere they could arrive at, from the eastward, in coming to Dover?"—'I am not able to judge of the maritime capacity of the Downs; but I should suppose, from what I see, that the Downs is safe, not very comfortable, but safe as a port; and I believe the holding-ground is good. I think it would not be at all difficult to secure it, in a military point of view, for vessels running in there. I do not mean to say it is impossible to do anything in Trinity Bay. I think it is wonderful what Captain Bullock has done upon the Goodwin Sands; and I will not pretend to say how far those measures might be carried out, and how far they might give further security in the Downs. There is no doubt whatever that a port in the Downs, to give to vessels lying in the Downs perfect security, would be a very desirable object; but I cannot say how far that system of Captain Bullock's can be carried out.'

"5627. In time of war, your Grace is aware that it will be impossible, with steam, for the trade to lie at anchor safely in the Downs."—'There have been instances of privateers coming into the Downs, and taking out vessels; but, now that there is steam, it would be perfectly impossible for 400 or 500 vessels to lie in the Downs. I should say it would be possible to give an increase of military security, so as to give complete security. I should say that it is a secure place in the main; but I doubt if it is a very comfortable place.'"

Report of the Shipwreck Committee on Light-Houses and Beacons.

"The numerous wrecks on the north-west coast of Cornwall induce your Committee strongly to recommend that one or more light-houses should be erected on that rugged shore. Towen Head appears to your Committee to be the most desirable situation, as it is in evidence that there is already a small pier near thereto, which might be extended so as to render it a fair harbour of refuge. Models of light-houses have been brought before them by Captain Sir Samuel Brown, Mr. Bush, and Mr. Steward; but, as neither of these has been tested, they do not offer an opinion upon them. Two light-houses, erected by Mr. Mitchell, upon a new and ingenious principle in regard to their foundation, having now stood the test of more than two years (one upon the foot of the Wyre Sand, off Fleetwood, and the other on the Maplin), the Committee do not hesitate to recommend to attention. They feel it right, also, to notice a beacon erected by Captain Bullock, of the Royal Navy, upon the southern edge of the Goodwin Sands, which now has stood two winters; and, having been erected at a very small expense (not exceeding 55*l.*), may prove of the greatest service if brought generally into use."

(*Lt.-Col. Colquhoun.*) Have you considered the means of applying your method of screw-piles into the sand to the construction of breakwaters?—We have not thought of that; one of the principal advantages of our method of building, is to allow the waves to pass freely without breaking them.

Do you consider it applicable to the formation of breakwaters?—I think it might be used better than other sorts of piling for that purpose.

Have you ever tried to screw piles into shingle?—Yes, the screws go very well into shingle. At Sunderland Harbour we have screwed moorings into shingle, and also at Bristol. Unless the stones are of a very large size, it works its way very well.

How many feet have they gone into shingle?—In the place I spoke of at Bristol, the screws went down 12 feet, 6 or 7 feet of which was through shingle, they were stones thrown

Mr. *John Mitchel.*
12th June, 1844.

in to prevent a bank from washing away; we have not screwed through stones of a large size, but anything up to the size of your hat, for instance, we can work through well; we can put on very great power, by using capstan bars of great length.

What force do you require?—That depends entirely upon the nature of the ground. Upon the Maplin Sands it required about 30 men, but at the depth of 15 feet, the sand grew so much softer, that I think 15 men would have screwed the piles in the remaining 7 feet.

What did you use?—A capstan head keyed upon the piles with long capstan bars which shipped into it.

How deep did your screws go at the Maplin?—22 feet below the surface.

Was the Maplin Sand dry at the time?—It was occasionally dry at very low ebbs.

Do you mean that you screwed it in at the first motion, was there no gear whatever?—No gear, except the bars, which were 16 feet long each.

Are your piles screwed into one another?—We generally make them in one piece, but where there is a greater length than 50 feet required, we make them in two lengths with a coupling, which admits of their being more easily managed.

Are they hollow?—No, the piles are of malleable iron and solid.

Do you know the maximum weight they would sustain; do you know what weight would cause them to sink?—That must depend upon the nature of the ground, but the screw at the foot of the pile being of such a great breadth would sustain an enormous weight, we have never known any of them to sink yet.

The work on the Maplin has not sunk at all?—Not the least.

(*Lt.-Col. Alderson.*) How is the foot of the pile armed; is there a little screw?—There is a small screw or opening bit to it.

What is the diameter of the screw?—Those in the model represent four feet screws.

Have you ever tried chalk?—No.

Do you think that by reducing the thread you could get through chalk?—If the chalk was not very hard, I think it might be done.

If you were to screw into chalk, would you require an enlargement at the foot of the pile at all?—No, the size of the pile would be sufficient.

Are you of opinion that upon the Goodwin Sands you would only have sand to bore into?—I cannot say, but I think from the form and position of the bank, that it is a very great depth to the chalk. I am of opinion that the chalk underneath the Goodwin Sands is a continuous line with the chalk that is found in the Downs and outside, and I believe that the sands were formed by countercurrents or eddy caused by the formation of the coast.

You have engaged to make a foundation upon that principle for the Trinity House for a beacon?—Yes.

(*Capt. Washington.*) Supposing a battery to be erected upon piles similar to the model now upon the table, and it was struck by a ship, a laden vessel, do you think the strength of it is sufficient to resist the blow?—I think some of the piles might be bent, as they are of malleable iron, by a large vessel coming against them with great force; but as they are intended to be of great strength, a foot in diameter, I think the vessel would be very soon knocked to pieces, so as to make her do very little injury to the structure.

You think the vessel would be more injured than the piles?—Yes.

If a collier were running down Swin with a south-west gale, and were to run against the Maplin Light, what would be the consequence?—It would do a great deal of harm, but I think the lighthouse might be protected, so that a vessel should not strike against it; there might be a chevaux-de-frieze of strong malleable iron piles, so that the vessel would hit that first, and that would destroy the vessel.

(*Chairman.*) Would not the expense of that be enormous?—The expense would be considerable, but if the support of that house were made much stronger, and of malleable iron, a vessel, unless she run her bow in amongst them, could not do it a great deal of injury. When vessels in thick weather, which is the time of greatest danger, come near enough to enable the crew to see the lighthouse, they try to avoid coming in contact with it for their own safety. A vessel came in contact with the Fleetwood Screw Pile Lighthouse, which we built, before it was finished, and struck it with considerable force, but did no injury to it.

[*The Witness withdrew.*]

Adjourned till to-morrow at 12 o'clock.

Thursday, 13th June, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Capt. *Vetch*, R.E.

13th June, 1844.

Captain *Vetch*, R.E., further examined.

(*Sir H. Pelly.*) In your printed Memoir on Havens of Safety, you point out the Downs as a site of great importance for the formation of one; state whether you mean the Great or the Small Downs?—The boundary between the two anchorages is not easily defined, but the site I have proposed comprehends the Small Downs, or anchorage lying to the west of the Brake, together with the space bounded on the south-east by a line drawn from Deal Sand to the Hook. The proposed haven will also embrace all the shoal ground northward to the Quern and Dike Banks.

What would be the total area of the enclosed or sheltered site, and how much of it would have four fathoms and upwards?—As far as the published charts and my other especial information furnish data, the whole enclosed area within low-water mark would be about 8000 acres, of which 2000 acres would have a depth of four fathoms water and upwards.

How much area would there be of five and six fathoms respectively?—Speaking under the same reserve as to the sufficiency of my data, the area of five fathoms and upwards would be 1200 acres, and of six fathoms and upwards 170 acres.

How do you propose to enclose and shelter this haven of safety?—On the south-east by an iron screen about 2260 yards long, extending from the Deal Sands towards the Hook Bank, leaving an entrance and tideway open between the south west end of the screen and the shore at Deal Castle of 1200 yards, and leaving another opening 1800 yards wide, between the north-east end of the screen and the Hook Bank; this last would constitute the main entrance facing the Gull Channel and the Goodwin Sand. The iron screen will be capable of adjustment, so that no more obstruction need be offered to the flow of the stream than is necessary to intercept the undulations of the sea; and as I propose the adjustable part of the screen shall be supported on stout iron frames, a space may be left between the foot of the screen and the bottom of the sea, so that while the undulation is destroyed at the surface, the tide stream may still have a scour upon the bottom, and the amount of this aperture below will also admit of any desirable adjustment. I propose to secure and strengthen the screen at either extremity by a solid pier 100 yards long, and at every distance of 240 yards to insert a solid pier of 20 yards long.

How is the shelter to be obtained for the proposed haven on the east side?—By taking advantage of the Brake Bank, and constructing upon it a spinal embankment in a north and south direction for a distance of about $3\frac{3}{10}$ miles. The average depth of water on the above distance being only about two fathoms, the cost of this work would not be comparatively heavy. A complete breakwater would thus be obtained, which, besides rendering the water much smoother inside, would prevent the bank from shifting, and would render the stream inside more constant and direct in its action, and undisturbed by gales of wind athwart its course.

In your printed Memoir you propose prolonging this breakwater north to the Race Bank, do you consider that absolutely necessary?—I consider it of great importance to continue it about half a mile further, in order to terminate it on solid chalk ground, and so effectually to intercept all lateral streams or currents that tend to injure a constant and direct flow through the haven, and to give the termination an outward cant, and the mouth a funnel-shape.

Would not such a prolongation have the effect of cutting off the Cliff End Channel?—It would have that effect, but I propose to substitute a new channel or entrance more suitable to the action of the tide-streams, and much more convenient for the shipping.

How do you propose to protect the north end of the Haven?—I propose to take advantage of the Quern Bank, and to construct a pier upon it 700 or 800 yards in length; and if that is not sufficient to add a similar work of smaller extent on the Dike Shoal; but I would endeavour not to interrupt the tide-way in that quarter more than absolutely necessary for shelter, as otherwise there would be some danger of a deposition of silt in the haven from the obstruction to the stream.

In the printed Memoir you have also proposed to prolong the breakwater on the Brake southward to connect with the Hook Bank, do you consider that essential?—I consider that prolongation would render the haven more complete and give a shelter to the deep anchorage against north-easterly gales; but as the Gull Bank, the North, and Middle Bars, serve to intercept the sea in that direction, perhaps this prolongation may not be indispensable; but such a prolongation furnishes the funnel mouth to the tide stream, which becomes more requisite when otherwise obstructed by screens and piers.

What are the number and nature of the entrances to this proposed haven?—There would be four openings or entrances: one 1200 yards wide between Deal Sand and the shore, for small craft; the depth at present is three fathoms, but on the construction of the screen it is highly probable the action of the tide-streams would deepen it possibly to four fathoms. The next entrance, that at the Hook, would be 1800 yards wide, this faces the East and the Gull Channel, and also the Goodwin Sands. This is the main entrance, and quite contiguous to the great extent of deep anchorage inside, and it would therefore prove very accessible to vessels passing through the Gull Stream in either direction, and would be equally easy to the egress of vessels with either a north or south destination; it would also be considerably sheltered by

the proximity of the Goodwin Bank, to which it is opposite. Lastly, there would be two entrances at the north end of the haven, abreast of Ramsgate, one on either side of the Quern Bank; and those, though shallow at present, might, I conceive, easily admit of deep channels being cut in them, and at no great expense; that on the inner side I propose to furnish with a channel three fathoms deep; and that on the outer or east side of the Quern I propose to furnish with a channel or cut four fathoms deep. This last being a substitute for the Cliff End Channel, this would only entail deepening the present channels about one fathom each across the shallow chalk ground; any sand or silt then standing in the way would, in all probabability, be carried off by natural action.

What advantage would this new channel possess over the Cliff End Channel?—The channel of the new entrance would be in the direction of the stream of the tides, and the northern portion being scooped out of the chalk edge, a new and clean channel and deep scour would be presented to the direct action of the tide currents, the effects of which would in all probability extend to the Small Downs, and connect that anchorage with the new entrance by a channel at least four fathoms deep. The Cliff End Channel lies apparently to the immediate south of the chalk edge and parallel to it, to which circumstance it no doubt owes its existence, as from its soft bottom, though in a lateral direction, it yields to the action of the currents, which the chalk edge resists; but the lateral action through the Cliff End Channel serves to divert the stream, and scour from their natural direct and useful course, and tends to create eddies and banks. The new channel is in the useful and natural direction, but the bottom being hard, a passage or communication of sufficient depth in the direct line of the tides can only be effected in the first instance by an artificial cut. Again, the direction of the Cliff End Channel right athwart the run of the tides is most inconvenient for vessels; and not only in that particular, but from being at right angles with their course, whereas the new channel would be equally convenient, both as respects the run of the tides and the course of the vessels passing from the Small Downs to the north, or *vice versâ*.

Are the works you have now enumerated all that are necessary to establish a complete haven of refuge?—All that are necessary to shelter and enclose it, and to provide commodious entrances. The construction of batteries and arming them would be an ulterior consideration. I have mentioned, that by deepening new entrances at the north end, a deeper scour would be introduced through the haven, and I may now add, that I am of opinion that if the Sandwich Flats were embanked, that measure would much assist in promoting the same object, and of procuring a better scour and greater depth of water over the whole interior of the proposed haven. The embankment of the Sandwich Flats may nevertheless be considered as an independent work which would repay itself from the value of the land reclaimed.

What do you consider would be the cost of the proposed works exclusive of the Sandwich embankment?—Adopting the principle of iron framings, &c., and taking every advantage of shoals and sand-banks, the cost of the necessary works would be small as compared to the old modes of proceeding; and I have estimated, roughly, that the amount required would be only about 750,000*l.*; but without recent, especial, and detailed surveys, it is difficult to attempt any great accuracy of estimate; but allowing for the worst state of the case and for all contingences, I have some confidence in believing that the cost would fall short of one million sterling.

In what time do you consider the works could be accomplished?—I should allow one year for preparation and three years for execution; if great celerity was required.

You have proposed certain works on the Goodwin Sands, will you state the precise objects of those, and say whether they have any immediate connection with the haven in the Small Downs?—The Goodwin Sands are to the Great Downs or outer anchorage what the Brake Bank is to the Small Downs or inner anchorage, namely, a natural shelter or breakwater from north-east to south-east; but I should deem it impossible to form the Great Downs into a haven of safety; nevertheless, I expect several important advantages if the works I have proposed on the Goodwin Sands can be successfully carried out; but I am well impressed with the difficulty of all works on such a site, and have only speculated on the probability of success, and therefore wish it may be clearly understood, that the project of providing a haven of safety at the Small Downs is entirely independent of the success of any erection on the Goodwin Sands; and all I would recommend in respect to the latter at first would be, some experiments to test the practicability of the principles proposed to be applied there.

Supposing your project in respect to the Goodwin Sands to prove successful, what benefit do you expect to derive from converting them into a dry bank or island?—These sands being situated in the line of a great trade and navigation, and in the immediate vicinity of frequented anchorages, they have been found at all times very dangerous to shipping, from the great extent of shoal water they present, and from the indraught upon them by currents across them; and as they must be almost constantly under the lee of vessels passing on one side or other, it follows, that in thick and blowing weather, they will prove sources of solicitude and danger to the numerous vessels on that track; and my project consists in an endeavour to raise the crest of the Goodwin Sands above high-water mark, so as to render them at all times visible, and to stop the indraughts and currents across them.

Do you expect to derive any other advantages from raising the crest of these sands above high-water mark?—The conversion of the Goodwin Sands into a permanently dry bank would much improve the shelter to the anchorage of the Great Downs, at all times of the tide, from north-east to south-east, and would completely shelter the entrance to the haven of the Small Downs; but if the Goodwin Sands became an island, it would always present a safe lee-side where vessels in distress might find a shelter; and though I do not expect they

Capt. *Vetch*, R.E.

8th June, 1844.

would resort to its lee-side as to a haven of safety or roadstead, yet in so great a thoroughfare for vessels it must often happen that a ship in distress would be saved from destruction by daring to run close under the lee of a dry bank, which they could not venture to do in respect to the Goodwin Sands under present circumstances. Again, on the weather side of the island vessels would not have the indraught to contend with, and even if they grounded, the crews would in all probability be saved, and the vessel stand a much higher chance of being got off.

If a harbour of refuge were to be formed off Dover, would it not prove equally useful with one at the Small Downs?—Any harbour of refuge formed off Dover, being necessarily a work entirely of art, must be of comparatively limited extent from the great cost of construction; and being small, the entrances must be narrow in proportion to preserve shelter inside. The harbour proposed in the Harbour Commission Report of 1840, at Dover, encloses an area of 400 acres, whereof about one half or 200 acres is of four fathoms water and upwards. At the Small Downs the anchorage contains 2000 acres of four fathoms water and upwards, and the main entrance is 5400 feet wide, that is, the anchorage would be 10 times more extensive, and the entrance seven or eight times wider than at the proposed harbour at Dover. The main entrance to the haven of the Small Downs is sheltered by the Goodwin Sands; that at Dover is quite exposed. The completion of the necessary works off Dover would be apt to cause an accumulation of silt and shingle inside. The completion of the works at the Small Downs would tend to deepen and improve the anchorage there, and prevent deposition. The drift shingle ceases at Sandown Castle, but is very active near Dover. From the narrowness of the entrances to the proposed harbour at Dover, and from their being situated in an active tideway, I should fear that they would not be easily accessible to a number of merchant-vessels if caught in a gale of wind, particularly in thick weather. Steam-boats and men-of-war would probably find no difficulty in gaining access, but to numerous traders of bad sailing qualities and indifferently manned, I should not conceive the proposed harbour at Dover would prove so serviceable in foul weather, and still less in time of war, when whole convoys are seeking shelter at the same time. Dover does not appear to me to be situated at so critical a point of the coast for vessels *en route* as the locality of the Downs, which forms, as it were, a neutral port for vessels that are prevented pursuing their voyage (either up the river or down the Channel) by westerly gales; from the violence of which at the Downs they are completely sheltered. On the other hand, the coast at Dover is quite exposed to a south-westerly gale, so that vessels caught in one and coming up Channel would prefer passing Dover and running into the Downs; while vessels proceeding from the river would much more readily fetch the Downs if caught in a south-wester, but might find much difficulty in reaching so exposed a point as Dover, and to attempt which they could have no inducement; yet the south-west gales are the most violent and common off that part of the coast. I am therefore of opinion that no harbour at Dover could obviate the necessity of a haven of safety at Deal for our mercantile marine. If for war purposes only, Dover, as a site, is perhaps better calculated both for offence and defence, and it is better situated as a packet station; but the great mercantile marine of Britain must resort to the Downs; and where our trading ships collect there ought also to be our ships-of-war and batteries to protect them.

Would you then propose to leave Dover entirely in its present state?—As a packet-station and as a shelter to a few war-steamers, it would be desirable to construct a safe landing-mole for all times of tide, and to erect so much of a pier or breakwater as would give sufficient shelter to a requisite number of war-steamers.

You have given an opinion that a sufficiency of scouring-water could not be procured by artificial means, at Dover, to keep the proposed harbour of refuge there free from silt. Will you state, more in detail, your reasons for that opinion?—The shore at Dover is so occupied by houses, and backed in by rising ground, that a basin or reservoir for scouring-water would necessarily be of very limited extent, or, in fact, would be restricted to the devoting of the whole of the present tide-harbour and pent to that purpose; in all about 25 acres, or one-sixteenth of the harbour proposed to be scoured. At Ramsgate, the outer harbour contains about 30 acres, and the scouring-basin about 15 acres, or one-half; and this is not found too much. Indeed, if it were not found convenient to keep a quantity of silt in the harbour, for vessels to ground upon, the scouring-water would be insufficient to keep the harbour clean; but the bottom of Ramsgate harbour, being hard chalk, much assists the action of the scouring-water; and, from the harbour at Ramsgate being shallow, and the scouring-water being flushed off near the time of low water, the discharge acts directly against the silt; but, at Dover, a discharge of water from the tide-harbour would act upon the silt on a bottom of four, five, or six fathoms. It is easy, therefore, to judge how comparatively small must be the effect of scourage under such different circumstances; and I may roughly state it as follows:—Difference of proportional areas of scouring-basins eight times greater at Ramsgate. Difference of effect, from nature of bottom, is two to one in favour of Ramsgate. Difference from depth of water, in favour of Ramsgate six times; that is, the scouring effect of Ramsgate would be 96 times greater than at Dover, by using the whole of the present harbour and pent as a scouring-basin; but if the proposed harbour at Dover was much diminished in the extent necessary to meet the objects stated in my last answer, then the scouring effect would be augmented in the same proportion nearly.

(*Chairman.*) Will you have the goodness to mark upon the chart the part which gives you four fathoms over 2000 acres at the Small Downs. (*The Witness marked the same upon the chart.*)

Does this refer to Captain Bullock's recent survey?—I got my information from Captain Bullock's recent survey, therefore it includes his amendments.

(*Lt.-Colonel Alderson.*) You speak of an iron screen, capable of adjustment, so that no

Capt. *Vetch*, R.E.

13th June, 1844.

more obstruction need be offered to the flow of the tide than is necessary to intercept the undulation of the sea; have you any model to show that?—I have not.

Then will you be good enough to describe it?—I have a rough drawing here, which will perhaps give an idea of what I mean. (*Producing the same.*)

Will not the machinery by which you propose to adjust your screen be liable to be out of order?—The adjustable rods will be all fixed by collars and keys, and their position cannot be altered unless by workmen sent for the express purpose.

(*Chairman.*) Are you aware that the Brake Sand has been ascertained by Captain Bullock, the Admiralty surveyor, to have shifted in bodily half a mile towards the shore, and that the change is shown in the Admiralty chart?—I have heard that stated, and I have also heard it contradicted; but it is certain that either the bank has shifted half a mile in half a century, or that the chart of 1795 was then incorrect as it is now.

Is it known to you that the Commissioners lately examined the Brake anchorage, and found throughout less water than they were led by the reports to expect?—I had not heard that fact; but, from the inspection of Captain Bullock's recent survey, I understood that would be the case.

(*Sir Howard Douglas.*) You have alluded to works of defence; is it possible to erect any works of defence on the breakwaters you have now proposed?—The breakwater on the Quern, and most of that on the Brake, would be filled up solid, and therefore any extent of battery could be constructed on them; and, in regard to the screen, the solid termini and piers would permit of the same application, so far as they extended.

(*Chairman.*) Have you examined the Small Downs and their locality, yourself; or are your suggestions founded on information collected from others?—I have been repeatedly along that coast, and sailed over it. I have not made any soundings myself. I should say they are founded both on personal inspection and on information.

Have the goodness to state what has been the nature of your personal inspection?—My opportunity of personal inspection has arisen from a residence at the locality, by examining the coast repeatedly, and by sailing over the ground; but I have not made any soundings or measurements; those I have taken from the Admiralty charts, &c. Lastly, I collected information from every pilot and coast-guard man I came in contact with.

Have you heard that, in skirting round the buoys laid down by the Trinity House within the anchorage of the Brake, the vessel we were in got into much shallower water than we expected?—I heard as much; and I think it a highly probable circumstance, because the Brake, being entirely exposed to the north-easterly gales, must constantly tend to the west, unless fixed as I propose, by an embankment, and unless counteracted by works to procure a more active and counteracting current inside.

Is it known to you that, for a very long distance throughout the anchorage in question, the vessel we were in was in such shallow water that she would have been aground in any part of that distance if it had been low water, while the chart from which you profess to get your information showed an ample depth at low water?—The chart which I consulted shows a depth of only two fathoms at low water, on the Brake Bank, and towards the head of the bay near Ramsgate; but that chart is founded on the recent survey of Captain Bullock; and the anchorage to which you now allude cannot be what I have referred to. From the action of natural circumstances, I can very easily conceive how the material of the Brake Bank has been thrown over from the outer or exposed side to the inner and sheltered one, and how the deep channel on the inside, shown on the old chart, has been so much filled up; and all the works I have proposed are for the express purpose of preventing the Brake Bank from further shifting, and also for the purpose of restoring what is now so much wanted—a deep-water channel inside of it. If the crest of the Brake Bank can be raised above high-water mark, the material will be prevented being carried across to the inner side, and deposited in the channel; and if a pretty strong current can be brought along the anchorage-ground, we shall have the same deep water brought back again.

Are you aware that the corporation of the Trinity House, with their accustomed regard to the interests of the commerce of the country, have issued a printed public notice to all the maritime world, that this great shift in the Brake Sand has taken place?—I have not seen that notice.

Supposing the fact to be as stated, are you prepared to propose to the Commissioners to recommend an outlay of nearly a million of money in such a situation?—It appears to me that if this embankment upon the Brake had been constructed 50 years ago, this deterioration of the anchorage could not have taken place, because the sand cannot move in a dry state; it is the water flowing over and across the surface of the bank which enables the matter to be carried over and deposited in the channel inside. But this lateral shifting of the Brake Bank is so perfect an illustration of what I have stated in my Memoir, that I beg to be allowed to quote the following paragraph; and I should also beg to submit for consideration, that if the Brake Bank is travelling westward, at the rate of half a mile in half a century, whether it is not important to take every reasonable means to prevent so great an evil as that circumstance is creating:—

"Those sand-banks, emanating from the deposition of matter in the eddy of a great stream, and resulting from great natural features of the adjoining coasts, may be considered the most permanent in their form and extent; because so long as the eddy-ground exists, it will offer a place of deposit to the matter with which the stream is charged, nor will the matter be easily removed again from thence; but a long narrow bank, deposited in a tideway parallel to the current, occupies almost an accidental site, and may owe its immediate origin to some accidental nucleus, as a wreck; and, therefore, if a slight adventitious cause was the origin, adventitious causes (such as a great storm in a vulnerable direction)

Capt. *Vetch*, R.E.

3th June, 1844.

may alter them. Thus, during the last half century, while the Goodwin Sands do not appear to have altered materially in form and size, I learn from the late able investigations and surveys of Captain Washington, R.N., that the long narrow tideway sand-banks off Yarmouth have undergone considerable and frequent changes; but it would appear, as might have been expected, that the quantity of material remains nearly the same; and that, while one bank, or one portion of a bank, has lost matter, other banks or other portions have gained in the same proportion; and thus partial oscillations arise in those banks that owe their particular situation to no very determined action in the selection of the spot. The long narrow form of these banks also renders them more easily disrupted or breached by storms running across them. It therefore becomes the more important, in respect to sand-banks of this species, which are used or required for breakwaters to anchoring-grounds, that the aids of art should be called in to give additional fixity to the location, and to strengthen their form against the attacks by storms; and any particular bank fixed and secured by having its crest raised above high-water mark, while it would no longer be liable to be spoiled of its own materials, would be apt to absorb and retain the spillings of adjoining banks, and become ultimately a dry bank or island."

You speak of your work along the Brake being inexpensive, because it will be generally in a depth of only two fathoms; will not a considerable part, at the south end of the Brake, be to be carried on in five and six fathoms water?—In five fathoms.

For what distance?—About 1800 yards. But I have already stated that, though desirable, this portion is not indispensable.

You propose to cut channels on each side of the Quern Bank, so as to get a depth of three fathoms on one side, and four fathoms on the other. By what process do you propose to deepen the channels?—It would require a steam-vessel, with a particular apparatus for breaking up the chalk and dredging it.

You naturally anticipate much advantage from the cuts you propose, but, in point of fact, is there not always a risk of mischief in altering the natural direction of the tide?—The ridge of chalk at present opposes the natural direction of the tides. These cuts would permit them to continue in what would be their natural direction, but for the chalk ridge.

Is there no apprehension, from the direction you give to the tide by the cuts, of carrying the sand to the harbour of Ramsgate, and forming an accumulation?—I conceive just the reverse, that the scour would then become considerably greater abreast of Ramsgate Harbour.

Then where do you suppose it will be carried?—A breakwater being constructed along the Brake Bank, all travelling matter would naturally deposit on the lee side of that barrier, and the deposition would consequently be most apt to form over the surface of the Brake Bank, and what was deposited along the edges would be thrown up, when they became the weather side, against the line of sustention thus provided.

You have said in a previous answer, "The channel of the new entrance would be in the direction of the stream of the tide, and the northern portion being scooped out of the chalk edge, a new and deep channel and deep scour would be presented." Will you make out where that chalk edge goes?—*(The Witness marked the same.)*

You speak of estimating roughly that the cost of your proposed work will be about 750,000*l*. Have you any specification or detailed estimate of the work?—I have not, but I have gone into the estimate roughly in different ways, and I have come to nearly the same result by different modes of making it.

Does your estimate of 750,000*l*. include all those cuts?—It does not include the cuts.

It does include the works upon the Quern?—Yes.

Is it known to you that in the last three years the average number of vessels that have gone into Ramsgate Harbour amounts to 1600, exclusive of the craft of the port, and that 460 sail have been there at one and the same time?—I have not seen the returns of those particulars during the last three years.

If only a limited sum of money is to be spent in harbours, do you think it would be judicious to expend it in constructing an artificial harbour within two miles of a port capable of giving such extensive shelter, and to neglect other more prominent and important parts of the Channel?—Ramsgate Harbour is a mere tide harbour, where small vessels can only enter from half-flood to half-ebb, and must take the ground at low water, and where East Indiamen and other large merchant-men cannot find water at any time. A harbour of refuge, I consider, ought to be a harbour where vessels of all sizes can freely enter and depart, and ride at anchor in safety at all times of the tide; and no vessel, *en route*, would enter Ramsgate Harbour so long as they can remain safe in the Downs.

The material you use is chiefly iron; what duration do you suppose iron will have in the situation you propose in the wash of the salt water?—I have proposed iron to be used as framings, either independently or filled in with concrete. If used independently as in the proposed screen at Deal Sands, it might be expected to last a century at least; but used as it would generally be with concrete, I see no reasonable limit to the duration of the structure.

You state that you should require one year for preparation and three years for the execution of your work; what number of days of interruption do you calculate upon working in a situation so exposed to the sea?—Upon my previous examination I had the honour to present to the Harbour Commission a memoir which I had written on the construction of these piers, and accompanied with a calculation of the time required to execute them, and as the process is simple and easy I will take the liberty of referring to it. "In the construction by iron framing it is reasonable to assume that a frame of four feet may be set each tide, and by working from two ends 16 feet per diem ought to be performed in good weather."

What allowance do you make for the interruption by bad weather?—I believe I computed at the rate of about four days in the week of uninterrupted work.

Capt. *Vetch*, R.E.
13th June, 1844.

Two days of interruption?—Yes.

It appears that, on an average of six years in constructing the Plymouth Breakwater, the interruption amounted to 183 days in the year. May we not reckon on the probability of a similar interruption in the Downs?—At Plymouth Sound the materials had to be conveyed in lighters or vessels, but upon this principle the pier goes on progressively from one end to the other, and the materials are brought up from the pier itself, independent of the state of the winds and waves.

In your printed work you make a sensible and very striking observation and suggestion. You say, "Notwithstanding the apparent feasibility of the plan proposed to fix these ever vexed and vexing sands, expectations may be disappointed, and nature refuse the remedy; but if such conciliating and gentle means are rejected, it may be doubted if more violent measures will succeed." You then go on and say, "It is estimated that an experiment on a sufficient scale may be made for 500*l.* or 600*l.*" As you admit your proposition to be experimental, and open to doubts as to its success, will it not be wiser to take the precaution you have so well suggested, and make a trial on the scale you propose, rather than at once spend nearly a million of money on the experiment?—Unquestionably; I beg leave, however, to observe that the remark quoted applies to the mode of treating the Goodwin Sands, and that the mode proposed to be adopted on the Brake Bank would be a very different one; there I should propose to construct a regular pier with platform, and push on constantly from the end, and bring up the materials on the platform along the finished portion of the pier; and the rods would be made to penetrate at once to the required depth; but, nevertheless, I consider a satisfactory experiment on the Brake Bank as essential a preliminary there as the other would be on the Goodwin Sands.

You would propose to make an experiment on the Brake Sands, on a small scale, first?—Yes.

To what extent would you go in making that experiment, to the extent of 500*l.* or 600*l.*, or what amount?—I should consider that a fair experiment on the Brake Bank, upon the principle proposed, would require about 300 yards, and that the cost may be taken at 60*l.* a-yard, making 18,000*l.*

Can you suggest any spot where an experiment on the limited scale you proposed of 600*l.* would be sufficient?—I think the Goodwin Sands, as Mr. Walker proposed, viz., the site for a beacon, would be very suitable for the description of work I have proposed for a sand, dry at low water.

You think that site for a beacon on the Goodwin Sands, as before suggested, would be a sufficient test?—Yes, for the class of work proposed there.

Is it not considered that the Downs is the place where a ship so far finishes her homeward voyage, that when she arrives there she has passed all the hazards of the Channel, whether with reference to the risks of navigation or of an enemy's cruizers?—No doubt a merchant-man on gaining the Downs is comparatively safe from any enemy's cruizers, but the Downs in its present unprotected state is not free from danger.

Do you mean by "unprotected" to refer to military protection?—To military protection and shelter from weather.

Is it not, in your opinion, in the narrow part of the Channel, between the South Foreland and Portsmouth, that ports of refuge are most needed?—The narrowest part of the Channel would be the most accessible to an enemy's cruizers, but the vessels must take their departure from a place of rest, and that place of rest, I conceive, ought to be a place of refuge, and the Downs is both a place of departure, and it is near the narrowest part of the Channel, and is important in respect to the estuary of the Thames and the North Sea.

Looking at the chart between the North Foreland and Portsmouth, where do you think it would be most judicious to place squadrons for the protection of the trade, and the purpose of watching the opposite shore?—Not being a nautical man, I have a great difficulty in giving an opinion upon the position of a squadron, but Dover being the most prominent point, would admit of a more ready departure for steam ships-of-war.

Your system of giving shelter to harbours appears only to admit of dealing with sands; have you no other proposition for a breakwater?—I have a proposition, to which I have already referred, and which I laid before the Admiralty, by which piers may be run out into deep water on the same principle, and those piers having been so run out, in skeleton shape, may be filled up and consolidated to any extent which might be deemed desirable. I was informed by the secretary of the Admiralty that when this Commission was formed the model and plans should be sent to it.

Have you ever thought of any plan on a less expensive scale, so as to improve the anchorage in front of Ramsgate at a cost which would come within the compass of the large revenue of the Ramsgate Commissioners?—It appears to me that a comparatively small part of my proposed works might be constructed off Ramsgate to render the tidal stream more effective abreast the harbour, and very much to improve the depth of water there.

Have you ever landed on the Goodwin Sands?—No, I have not.

You propose to make the Goodwin Sands an island?—I conceive that it is very likely that, with a comparatively small outlay, the sands might be made to accumulate and become a dry bank or island. I have been amongst them, but not on them.

Have you ever constructed any works such as you propose to erect in the Small Downs, or are your plans and specifications made in your study?—My plans and measures have not been tested by practice; they are new; but my study has been the book of nature, and I have endeavoured to read it rightly, and I have been led to form a strong opinion that none of our existing modes of construction are commendable or advisable, either at Deal or Dover, and that

Capt. *Vetch*, R.E.
13th June, 1844.

if anything is to be done there we must look to new contrivances or discoveries, all of which will require to be tested by satisfactory experiments previous to adoption, and among such new plans I respectfully submit my own, but shall be the first to wish to withdraw them when some more suitable method is proposed.

How long would you have your experiments tested before you considered the Government warranted in laying out a million of money?—I should consider that one winter would be sufficient to test the stability of the principle. A million of money can only be expended gradually on such a work; but even so, I should be the last to advise the adoption of any general or extensive measure upon a new principle without previous and satisfactory experiments.

(*Mr. Walker.*) Of what metal do you propose to make your rods for the screen?—Of iron.

Of what size?—Two inches diameter.

Solid or hollow?—Solid, though in some applications I have contemplated using hollow rods or tubes of a large diameter filled with composition.

What is the size of the rods that form the triangular framing at right angles to the stream?—Seven inches wide by one inch thick.

The external rods that form the triangle or outside of the frame, and the horizontal braces, are those referred to?—The external bars are seven inches by one inch, the horizontal rods two inches in diameter, the horizontal bars four inches and a half by three-quarters of an inch.

By what means do you, in deep water, lay the bottom horizontal bars, and the other parts which are under low water?—It is intended for deep water, and I propose to construct the screen in sections of 50 or 60 feet long, and to float them out in lengths, and drop them into their place, and then bolt them on to the sections previously laid down.

(*Lt.-Colonel Colquhoun.*) You state that four years would be required for your proposed construction on the Brake Sands, namely, one year for preparation and three for execution; supposing your experiments successful, could not the period of completion be accelerated?—By working from a greater number of ends, the work might be accelerated to any extent required.

(*Captain Washington.*) Will you be good enough to explain the nature of your screen?—It consists of a triangular framing of stout iron, coming to an apex a little above high water; those frames are bound together and supported by horizontal bars of the same metal, and in the centre, or from the apex a row of perpendicular bars pass down to the bottom of the sea. Those rods, which form the effective portion of the screen, may be either placed close together or at any required distance apart; and they may be either allowed to touch the surface of the bottom or to stop short at any convenient height for the purpose of bringing a scour over the bottom and preventing deposition.

Your screen being placed across the tide, is there not a fear that shoals will grow up under it?—The screen is proposed to be placed slightly oblique to the tide, and by keeping the rods forming the screen a short distance above the bottom, a scour can be introduced there which would prevent the accumulation of any matter near them.

Is the south-western end of your screen connected with the Deal Sand, or do you leave a western entrance?—It rests on the Deal Bank, leaving an in-shore passage for the tide with three fathoms water, and 1200 yards wide.

(*Chairman.*) Will you inform the Commissioners what your proposal to the Admiralty for a fixed breakwater, to which you adverted, was?—I will send to the Commission the written statement of the nature of it, together with a model and drawings.

Have you anything further to state with reference to your proposition to the Admiralty?—I have nothing further to state than that which is contained in the paper I have alluded to. I consider it particularly applicable if it is proposed to construct a harbour of refuge where there is a liability to silt, for you may leave as much of those piers open as you please to the action of the currents.

Would it not, in admitting the tide, also admit the shingle?—It would certainly admit the shingle if left open where the belt of shingle travels, but my principle gives the facility of making the pier solid where required, which will be its general condition; and the exception will be to leave it open, or in a skeleton form, in places where it may be desirable to introduce a passage for the stream.

Is the plan which you have proposed to the Admiralty applicable to an artificial harbour at Dover?—I consider that it is particularly so, in reference to the purpose of avoiding the deposition of silt.

In point of construction, do you consider it suitable, the whole of the proposed artificial breakwater at Dover being in from seven to eight fathoms at low water?—I conceive there is no reasonable limit to the depth of a breakwater on any other mode of structure in practice to which my principle would not be equally or more applicable, but of course with the depth the difficulties of each form of structure would increase.

You would have no hesitation in proposing your plan for the formation of a harbour at Dover?—The locality of Dover is a difficult one for any kind of structure; but if it be determined to encounter the difficulty, I know of no mode of accomplishing the same within a reasonable time and expense upon so feasible a plan as that which I laid before the Admiralty, or by means of iron caissons, as pointed out in my former evidence; and I should either choose between these two modes or combine them.

Would it be attended with inconvenience to you to state a proposition for a harbour at Dover?—I shall be happy to give the subject my best consideration, and to furnish an outline of what appears to me most practicable. If it is decided to have a harbour at Dover, having a screen at the west end would admit of the scourage, and give shelter at the same time; whereas without that you can hardly do so without damaging the shelter or admitting the silt.

1°20′ 22′ 24′ 26′ East 28′ Longitude 30′ 32′ 34′ 36′

Margate
North Foreland
Light House
Birchington
St Peters
Broadstairs
ISLE OF THANET
Ramsgate
Pegwell
Dike
Quarry
Crusted
Broad
Spur
Edge of chalk indicated by Soundings
Light Vessel
North Sand Head
Edge of chalk inferred from the Isle of Thanet
Isle of Wantsum
Creek
Stour R.
Sandwich Flats
BREAK BANK
Groin
Sandwich
Light Vessel
Bunt Head
GULL STREAM
GODWIN SANDS
Trinity Bay
Small Downs
2½ fms. lowe 3 fathoms Soundings
Hook
Groin
Safety Beacon
Spring's Rumbly
Deal
Deal Castle
Upper Deal
Deal Sands
Screen
Walmer
Walmer Castle
Ringwould
Edge of chalk inferred from opposite Shores
Edge of chalk indicated by Soundings
South Sand Head
Light Vessel
St Margarets
Light Houses
South Foreland
Dover
Harbour proposed 1840

Plan illustrating Lieut.ᵗ Yelik's project
for forming a
HAVEN OF SAFETY,
near Deal
& for improving the Navigation in that Quarter

a a Channel proposed to be cut thro' the Chalk 3 fathoms deep
b b Channel ____ Dº ____ Dº ____ 4 fathoms deep

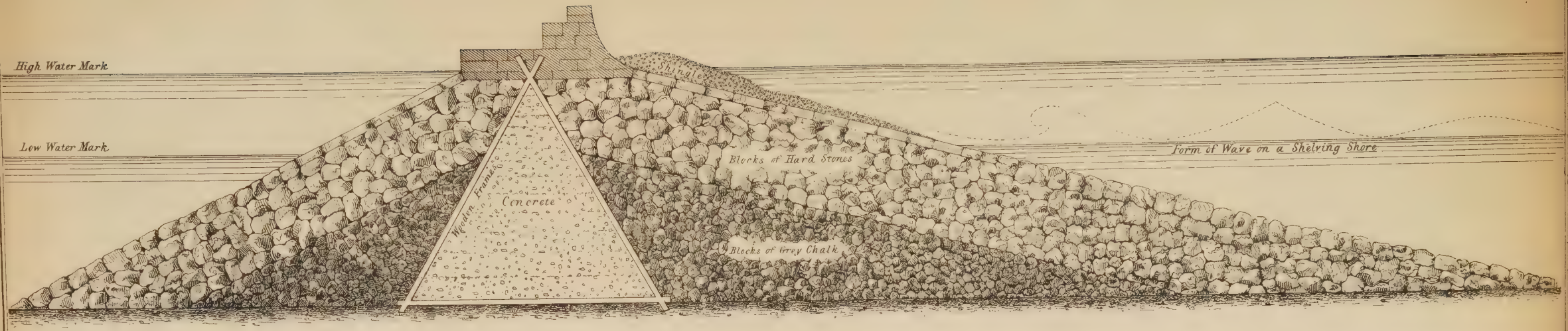
N.B. The figures denote lines of equal depth in fathoms below the low water of ordinary Spring Tides

1°20′ 22′ 24′ 26′ 28′ 30′ 32′ 34′ 36′

51°

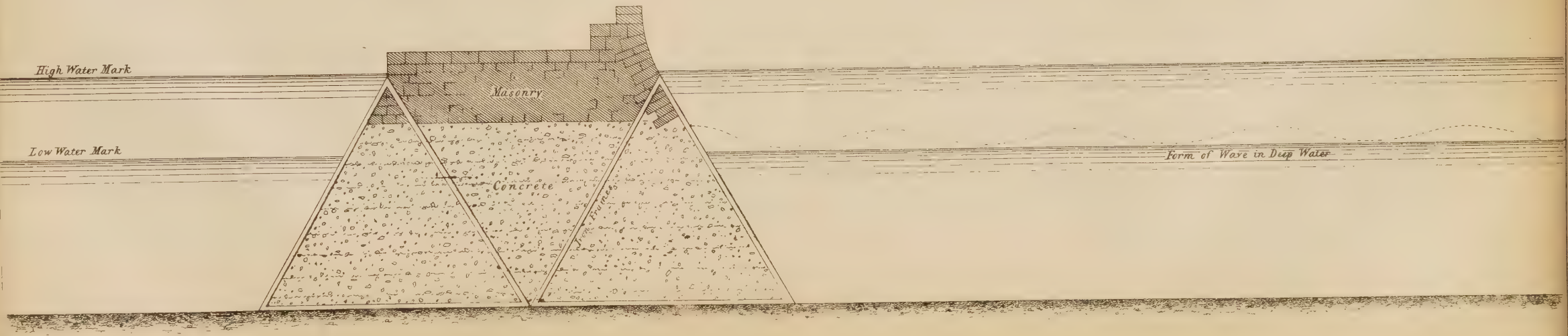
J. W. Lowry, Sculpt.

Sections to Illustrate Captain Vetch's Evidence.



Section of Piers for proposed Harbour at Dover by William Cubitt Esq.re

Scale, 30 Feet to 1 Inch.



Proposed Alteration on the Section of Mr. Cubitt, by Captain James Vetch, R.E.

Standidge & Co. Litho London.

Will you consider the proposition for a harbour at Dover with reference to seven fathom water at spring-tides?—I shall be happy to give every attention to the case, and state the results. Capt. *Vetch*, R.E. 13th June, 1843.

(*Mr. Walker.*) In your evidence you have stated that you consider that the erection of an iron screen at the south end of the Brake Sand would have the effect of improving and increasing the depth of water in the harbour, which will be formed in the Small Downs, be kind enough to state how you conceive that effect will be produced?—I have been misunderstood. The iron screen is for a very different purpose from the work on the Brake: it is a work of necessity to give shelter; but instead of improving the scour of the tide, it must, to some extent, diminish it; the breakwater on the Brake Bank, on the contrary, would have the effect of confining the tide-stream to a direct and constant action, and of preventing its dispersion from north-easterly or other gales coming over the surface of the Brake Bank.

But inasmuch as you protect in some degree the openings into the Small Downs by the iron screen that extends north-east from Deal Sands, do you not also decrease the current in the Small Downs?—That is just what I have been stating. The screen will intercept the flow of the northerly stream to the extent of the surface it interposes; and to compensate for that I have proposed that the south end of the breakwater on the Brake should have a cant outwards to receive and conduct a larger portion of the stream; also I have left a tide-way between the screen and the shore at Deal, and an opening between the foot of the screen and the bottom of the sea.

Do you think that in the current of water within the Brake, that is, the water in the Small Downs, where you propose to make your harbour, the effect of your works will be to increase the depth by means of increasing the tidal water?—With the exception of the screen which is necessary for shelter, and which will interrupt the stream in the least possible degree, the effect of the other works will be to increase the depth not only by augmenting the flow of tidal water, but by giving the same a more direct and constant action in one channel. I think if the northern and southern cants are executed, the Sandwich Flats embanked, and the cuts made through the chalk at the north end, there is no doubt a much greater degree of effective tide will flow down the present channel; but at the northern end you can extend the cant to any reasonable extent you please. It may be carried out to the north-east end of the Spur Bank, and a great body of the southerly set of the stream conducted through the proposed haven.

(*Adm. Dundas.*) Supposing that you had a breakwater coming off from the Deal Sands in front, and from the Brake, without any other work, would that give sufficient protection to the anchorage?—Yes, that would protect the anchorage; but I should be afraid it would damage the tide-way, and it is important to keep the anchorage clear.

In what way do you think it may damage the tide-way?—In proportion to the extent of the surface the screen opposes to the stream; it would, from its position, tend to throw the northerly set of stream into the Gull Channel, and therefore the necessity is greater for enlisting every other means of improving the scour.

What would be the inconvenience if the tide were turned as you suppose?—It would diminish to that extent the scour over the anchorage.

[*The Witness withdrew.*]

Adjourned.

Tuesday, 18th June, 1844.

Admiral Sir T. Byam Martin, in the Chair.

William Cubitt, Esq., examined. *W. Cubitt*, Esq. 18th June, 1844.

(*Chairman.*) In order that you might be the better prepared to answer the questions put to you, I believe a copy of the questions has been sent to you?—Yes.

Supposing it to be decided to convert Dover Bay, Dungeness, or other places into a harbour, with the sea front in seven fathoms at low water, having regard to economy, and to its speedy execution, so far as the same may be consistent with solidity and permanence, will you give the Commission your opinion as to the mode and materials for constructing the work?—The answer to the first question would depend in some degree on the consideration of the second question, which goes to the principle of a breakwater.

Considerable doubts being entertained as to the slopes, and particularly the sea-slopes of breakwaters, the least likely to be damaged by the action of the waves, you are requested to read a statement we have obtained from Lieutenant-Colonel H. Jones, of the Royal Engineers on this important subject, and to give us your opinion?—There are two or three modes of constructing a breakwater. The simplest is tumbling large stones into the sea, as Plymouth Breakwater and Kingston Harbour Pier; another mode is building in water with large stones, by means of the diving-bell; another by building caissons, filling them up partially, and floating them into their berths, and sinking them, and completing afterwards, either in or about them. All those modes are very expensive in deep water, and the expense increases much faster than in proportion to the depth; that is to say, pursuing the same mode, the expense will increase in proportion to the square of the depth multiplied by the length, as near as may be. The square of the depth of one breakwater multiplied by its length, will give a certain number representing cost; the square of another depth multiplied by its length, will give a proportional number, representing the cost of it; and thus the two may be compared. Touching

W. Cubitt, Esq.

18th June, 1844.

Colonel Jones's proposition, I agree with him, that in deep water, a perfect upright face from the bottom to the top would be the best, if of solid material, which could not wash or break away by the action of the sea; a solid face, for instance, inasmuch as the waves would have less range upwards by that than by any other means. But at the same time, such a breakwater, I conceive, would be the most expensive to construct. Touching the expense, I have not been able to go into the expense; nor, in fact, have I had time to get written answers prepared to these questions. But I formerly gave some evidence on the subject to some other Committee or Commission, or to the Treasury; I forget which, but I think the Treasury.

Respecting slopes?—Respecting the construction of breakwaters generally, and one kind in particular; that is, to construct a breakwater quickly with caissons, to enclose the space; and then to fill up outside and in with rubble to form slopes, as in the common breakwater; so that the advantages of an enclosed harbour might be obtained in a short time, at a comparatively small expense, but it would require subsequent completion to render it permament and durable. I could not give clearer evidence now on this particular subject than is contained in my letter to the late Chancellor of the Exchequer; but that went to less than seven fathoms of water. So that, if the cost of that was represented by 36 for any given length, say a foot or a yard, seven fathoms would cost 49 or 50 in round numbers. I believe that a breakwater with upright faces might be built absolutely in caissons 40, 50, or 60 feet high, completed to that height, upon Colonel Jones's principle (upright faces), built in caissons, and sunk in place, and completed by building within-side the caissons, after the tide has got below its top. For instance, we may imagine a breakwater with upright sides to be 60 feet high. We could build a cube vessel 60 feet high, with four sides and one bottom, make it perfectly water-tight, planked, and timbered, and it would swim; and in that might be built a stone fabric, either solid or hollow, perfectly upright faces, and exceedingly strong and well built; and that would float when loaded to a third of its whole depth, that is to say, it might be built in 20 feet thick. It would swim, and might be towed out and sunk, and then it could be completed in place. It would never move; it would be a solid stone cube of 40, 50, or 60 feet, or whatever dimensions might be advisable.

Does the plan you are now stating partake in any degree of Mr. Brenmer's proposition?—No; I had my plan in my mind long before I saw Brenmer's proposition. It would be possible, building and sinking one, to build and float off, and sink, and complete another close alongside it, and another, &c., in 40, 50, or 60 feet lengths.

Do you not, in your letter to the Chancellor of the Exchequer, mention 200 feet?—That is quite another plan; I am describing how it is possible to build a solid stone upright wall, taking the least possible materials, and getting the greatest possible quantity of strength.

Do you propose to have a protecting slope in front of the wall?—Not at all in that case, because the breakwater would be a perfect thing in itself—an upright face like a wharf, which is a difficult thing to construct out at sea.

Will you state what in your opinion would be the expense of constructing on your plan?—The expense I have not been able to go into at present; but I think I may venture an idea, that a breakwater in seven fathoms water is sufficiently above high water to answer all its purposes. A breakwater, in general, could not be thoroughly completed under something like 1000*l.* a-yard.

In either of those places?—I think a good breakwater in seven fathom water, on whatever plan it was made, to be good, would not cost less than 1000*l.* a-yard.

In what depth of water?—Seven fathom at low water.

Taking the rise of the tide?—Everything connected with making a breakwater to enclose seven fathom in low water; we must then add the tide, and the height above high-water mark, which would be more or less according to the plan pursued.

You are aware that the tide rises 18 feet in one place, and 8 feet in another?—If you make a breakwater with a long flat slope, you would have to rise it higher out of the sea to prevent the waves getting over its top than one with an upright face.

In constructing caissons for any marine purpose, which do you consider the best, wood or iron?—Wood for large ones.

What do you suppose would be the duration of wood?—I do not know, but I never use them at all, if the duration is of any importance; that is to say, the way I should use caissons would be to last 10, or 15, or 20 years; probably they would require to remain that time, and after that time it would be a matter of no consequence what became of them. I will give an instance. In the plan I gave Mr. Baring, the caissons were proposed to be built in lengths of from 100 to 300 feet, according to circumstances, and floated into place partly loaded, filled up with sand and shingle as the cheapest materials, and made solid; they then have a form and weight that no sea will move at all; they would then, as far as the breakwater goes, be a perfect breakwater to all intents and purposes, and they would last as long as the caisson lasted. It was then proposed to fill them up with flat slopes of rubble stone outside, that is, on the sea side and the harbour side, to form a solid mass, and carry that on subsequently to high water; and as soon as it was done, it would be of no importance if the timber should be annihilated. The duration of the timber does not form much of an element in the thing. Again, if we were to build a pier with upright sides in caissons floated out, they would be built so well, that the whole of the outside casing might be stripped off; for the duration of the timber should be of no consequence.

In following out the plan you proposed to the Chancellor of the Exchequer, what slopes should you give to your breakwater?—As a minimum, four to one, I stated, on the sea side.

Would you, if you were to prepare a breakwater on that plan, still persist in having

W. Cubitt, Esq.
18th June, 1844.

that slope, or would you have a much more upright slope?—I should have the flattest slope I could between high and low water, and it would form itself into a slope perhaps rather more upright below low water. I think the Plymouth breakwater in the form it has taken, in spite of anything to prevent it, will give the best idea of what a breakwater would be in heavy seas. Slopes of two or three to one knock to pieces very fast in a heavy surf, and beaches of nine or ten to one stand the sea the best.

Has Plymouth breakwater suffered great damage in the progress of its building to a very serious amount in point of expense?—Yes.

Therefore, what I understand you to propose is, to take it as it is shown in its present shape, and not as it was originally laid down?—As it now is shown, for we have the benefit of experience.

As the sea has cast it, so you would adopt it?—I think that is the form in which it would be most likely to lie with stones of the same size. I am speaking now of the part below low water, which takes its own shape. Above low water we could do what we please with regard to shape; but the great difficulty and the great evil attending making breakwaters in the open sea, is the deterioration which the work suffers during its progress. Now the piers of Kingston Harbour, which I frequently advert to because they are a very good case, were, I think, 15 or 16 years in building. They never stopped, but they used to be knocked to pieces very much at the tips where the stones are put from the waggons, and it was those contingencies which led me to think about forming a breakwater in lengths of about 100 feet or perhaps more, extensively built and sunk at once. The instance in which I tried caisoons was on a small scale, but they answered the purpose exceedingly well.

If you were called on now to construct a breakwater, is that the plan you would propose, to make the masonry and sink it perfect?—If I was to make a breakwater with sloping faces like that which is described in the Report on Shipwrecks, page 261, I should pursue the means there stated. I have not since built anything of the kind on a large scale, and I do not at present, from subsequently thinking about it, know of a better mode, because I feel satisfied that we can construct timber caissons sufficiently strong to withstand all the action of the sea, and to last several years. I feel satisfied we can build them sufficiently large to answer the purpose; I also believe they are managable at that size, inasmuch as we could tow a first-rate vessel into the roadstead, and lay her in any direction, and scuttle her, and sink her; and we could do this thing so much the better because we could scuttle the caisson by means of wells and valves and contrivances for the purpose which I did adopt for those that I sank, and they sunk remarkably well; they were in 100 feet lengths.

Where was that?—At a small harbour which I made on the coast which never was finished, and never answered as a commercial speculation, but the caissons, so far as the mode of making them went, answered very well; they answered their purpose.

You would feel no difficulty in seven fathom water in dropping the caissons with accuracy in their place?—None at all, because I should weight them down to four or five fathom before I sank them.

If caissons are used for such work, what length do you recommend as most conveniently manageable, and in every respect the best?—For long triangular caissons in lengths not less than 100 feet; but were I to build an upright solid pier on caissons, I should make the caissons, as near as may be, cubes of the total height; but, at all events, cubes of the low-water height, because when we are above low water we can build without the need of a caisson at every tide.

Is it your opinion that the hard chalk with a facing of granite is desirable to be used in the construction of breakwaters?—I have some little doubt about it. If it could be carried on quickly and covered soon with harder stone, I should say a great deal of the best chalk might be used; but pitching the chalk into the open sea, as breakwaters are usually made, I do not think it would make a good job; we could not be always sure that it would go into the right place, and it is not equal to stone; but if it could be built in and immediately covered, so that the action of the sea could never get to it, then it would be as good as any other material so placed. For instance, if we were about to build an upright breakwater or pier with upright faces, and in square caissons, then the hardest chalk might be used in the hearting of the work exceedingly well, and so might bricks and cement, and all the cheaper modes of building.

Will you be good enough to give your opinion on the various sketches now put before you, showing the lines of the proposed harbours, together with such modifications of the same as you may be prepared to recommend?—Taken abstractedly, any of them are good; and if they could be made, would be very useful harbours; the larger the better, and for that reason the largest would be the best.

Where would you recommend the entrance to be?—The entrance would be best towards the middle and at the most projecting point. Some of these, I think, I had a hand in scheming, and some not. I approve entirely of an enclosed harbour, being, as I understand, the best. There are two principles upon which I think a harbour at Dover may be constructed. One principle is a close harbour, and to that I assent. I close it up at the west; and a close harbour so made would be the best, considered as a harbour; it would be the quietest, and possess every other good property but one; and that very evil property is the property which made me draw a breakwater and not a closed harbour. Do what we will, I am afraid, on the south-east coast, as soon as we close the harbour it will begin to silt up, therefore a close harbour is the best harbour so long as its bottom keeps in the right place. To obviate that difficulty, and to do it in a way which could be remedied if not approved of, I drew this as a breakwater with sufficient openings to let in an indraught and sufficient sea to

W. Cubitt, Esq.

18th June, 1844.

prevent the silt depositing on the bottom. The proposition was with that view to have the openings large enough so that there might be both a run of tide enough through it, and sufficient action to have the properties of a good harbour as a roadstead harbour, and sufficient motion to keep it from filling up, and that is the point to which the whole essence of making a harbour must be directed, so that it will not fill up, and so that it will be quiet enough; and between the two it is difficult to draw the line.

It has been stated that you approve of the suggestion of Captain Beaufort and Colonel Thompson for making it with only one entrance?—Yes, I do; and that would make the best harbour.

If it was made with one entrance only, can there be no run of tide?—No.

Is it not objectionable on that account?—It is not objectionable on any account, except the one I mentioned, that of its being a still-water harbour, the water will come in muddy and go out clear.

Will not the other entrance at the eastern end tend in some degree to diminish by making a draught of tide through it?—The mere entrances, I think, are not enough for that, and I think the two entrances would do little or nothing with that; they would not let in even wave enough to keep the water in motion, even in rough weather. It is the nicest point and the greatest difficulty attending the making of harbours. I did not state to them my reasons; they put to me the plain question, "Do you object to closing this up?" and I said "No, I think it would make the best harbour by closing it up." I have since that time learnt how they do fill up.

What do you think would be the effect of keeping the bottom in a constant state of disturbance on the ebb-tide by any process?—The effect would be exceedingly good, but no process, I think, would answer the purpose and pay the expense.

Not to lift it up, but to keep it in a state of agitation?—I could imagine a fleet of steamers going across and across every ebb-tide, and stirring it up; but it would be exceedingly costly, and would very much interfere with everything going forward in the harbour.

Could it not be effected by harrowing or anything of that kind, and constantly working upon it?—It would effect the purpose, but it would be too costly, and interfere too much with the business going on in the harbour.

Are you in favour of a double entrance or not for the convenience of getting out?—I am.

By entrance was meant also a passage for water to give, if it might do so, some movement?—Yes, but by being closed at the west there would always be the quietest water and the greatest deposit where the motion is most wanted, that is, at the western end. These openings in so large a harbour would give a very little in draught.

Which entrance do you most approve of?—The middle entrance, a little westward from the middle. I should take the entrance at the most projecting point, wherever that may be.

In order that the shingle may pass more readily?—Yes, that is one reason; and I think it is also best to enter with wind a little scant.

Do you not think that ships coming in with a heavy gale of wind would have a greater command of the anchorage at the western entrance than in the middle?—They would have a better choice of ground, no doubt. The plan attached to the report of the Harbour Commission of 1840 has three entrances; one to the westward, one in the middle, and one to the eastward; but in sending my report and plan to Mr. Baring, I laid it down as a breakwater with a considerable opening at both ends, so as to cover the bay; and then experience would determine whether it should be closed in at the west or not, because I am sure that would have made a good anchoring ground and quiet water, but not so quiet as to form a deposit. That was the only object I had in view.

Do you think if it was left open as you originally proposed, the shingle would come in in such quantities as would be likely to fill it up?—That was the objection; but I think we could build up a breakwater, for instance, a jetty, into such deep water that the shingle would not get round it. The shingle gets round because the south-westerly winds overpower the north-easterly winds on that coast; and we have had a very strong example of that at Dover this spring.

If you were to build a breakwater as you propose at Cheeseman's Head, would not that prevent a run of the tide?—It would in a great measure; it would obstruct the fair run of the tide; but I think there would be a sufficient set of tide into it to prevent anything like a deposit.

To what depth of water would you run it out?—Six or seven fathoms.

Would that mode of constructing a breakwater detached from the shore be expensive from having to load vessels and afterwards deposit instead of wheeling out?—Yes. The plan with caissons would be the easiest way of making a detached breakwater; but if there were slopes, it would have to be filled up from vessels; but if an upwright one, it could be built solod at once. It is altogether a very difficult subject, because there is not a single thing by way of advantage that has not something countervailing it.

In the report we got a few days ago from Dublin, it does not appear that the harbour has filled up so much, though there is only one entrance?—Very little, and the reason for that is, that the clear ocean water there comes in clear, quite blue, and here it come in like milk. I know Kingstown Harbour very well. I have watched it tide after tide, and week after week sometimes, and it silts up nothing, I may say; it is imperceptible, in fact; but on this coast, with the mud and the chalk together, all along the shore the water is turbid, and it is very plainly to be seen, especially along the cliffs; and it is due to the breaking away of

W. Cubitt, Esq.

18th June, 1844.

the chalk in a great degree. At Folkestone, which is to the westward of Dover, the cliffs have terminated, and as the flood tide goes from Folkestone to Dover, none of the chalk debris from these cliffs, I believe, comes into Folkestone Harbour; the water comes clearer there than it does at Dover, still the tendency is to silt up. I have had that harbour cleared out to a flat inclined bottom, and since it has been cleared out, in less than one year there is a very considerable deposit from the sea.

What is the deposit?—A yellowish mud, and it is very annoying to see it coming. If a harbour like that will begin to do so and show it so soon (and we know that Dover does it very much), a larger and close harbour, if made equally still, will do it also; and if done to the extent of three or four inches per annum, it will very soon ruin the harbour as a still-water harbour; moreover, I do not think (if we talk of a close harbour) we ought to let the land-waters come into a close harbour.

Then according to your idea we must either be content with a breakwater outside the bay, making it a good anchorage, without being a close harbour, or take the risk of rapidly filling up?—I would begin the breakwater first, which would be a piece of a close harbour, but I dread silting up more than anything else; still I say a close harbour is the best.

(*Sir Howard Douglas.*) What upon the whole is the shape of profile of the breakwater you would recommend as best calculated to resist the action of the sea?—I say again, I believe in deep water, upright; and I draw that conclusion in part from what I have seen and in part from what I have heard and read. In the first place, where the rocks go very deep into the sea on the north-west coast of Ireland, and at some of the islands on the north-west coast, I have seen a heavy sea come rolling in and rise and fall against the upright faces much more quietly than on any sloping beach, whatever may be the slope. I have also read and heard a great deal about coral reefs surrounding the tropical isles, many of them where there is a heavy sea outside, and perfectly smooth water inside the reef, having a perpendicular face outside, and the surface or top of the reef very little above the water. Therefore from those things, and what I have seen with respect to the rocks, I think an upright face of good material is the best. I should have no hesitation in building a solid stone breakwater in six or seven fathom water with upright faces, leaving expense out of the question; and I think nothing would be easier and nothing would be better. Again, if we take the cross sections of a breakwater in seven fathom of water, like Plymouth Breakwater, it will take so many cubic feet of stone for every foot in length, perhaps four times as much as the profile of a solid upright one. Then we might pay four times as much for each cubic foot without incurring more expense; but if we have a better thing, it is better upon the whole.

Then, you think there would be no great difference of expense in the two modes of construction?—Not a great way off, I think.

What is the amount of resistance of an upright breakwater to the action or momentum of a heavy sea or wave compared with the resistance which a sloping breakwater presents in the direction of motion: is it not well known that the resistance to such action in the direction of motion is diminished in a certain ratio, according to the obliquity of the surface struck? The theorem, I believe, is, that it is diminished in the ratio of the cube of the radius to the cube of the sine of the angle of obliquity; and as this is a well-known theorem in oblique forces, I want to know whether you consider that the conditions of the case we are considering, viz., that of erecting breakwaters to resist the action of the sea, are not subject to those laws?—It all comes into the question of resolution of forces. If we lay a face exactly at 45 degrees, and impinge horizontally, it will fly off perpendicularly, there is no doubt; and so in proportion to the sine of the angle; but in an upright wall we must treat it as the action of a wave, and the wave will rise much less against an upright face than it will run along up an oblique face, and it will attain much less height.

Will not the direct impulse of the wave be greater against the upright face?—I think not; because the height to which it rises will be so little compared with the other. A sea would run over a breakwater 20 feet higher than the level of the water in a sea which would not rise above 6 or 7 feet upon the upright face.

For the very reason that the sea would run over, the breakwater itself will receive a lesser shock?—No; because there would be such a small slice of water to go against it. And again, on the same subject, if I were to build a solid breakwater with upright faces, I should always build it as wide as it was high; and I think that would stand any sea.

What would be the expense of that compared with a sloping breakwater?—I have just been endeavouring to explain, although I could not answer, that it would take a much less quantity of material. We could afford to pay so many times more per cubic foot for the work as the section was times in the one case over the other.

Would that depend entirely on the cost of the material at the place?—Yes. I have just said that, if in a rubble-stone breakwater, 1*s.* a foot would be the price of rough material; and it contained four times as many feet in the sectional area, we could afford to pay four times the price per cubic foot to obtain a solid one.

Would you consider chalk applicable to this purpose in that mode of construction?—No? no chalk for outside work.

You said that an upright breakwater should be as wide as it was high?—We will take 7 fathom at low water, and 3 fathom tide; that is, 10 fathom, or 60 feet. I stated before, I would take the cube of the low water; that is from 50 feet cube; the base and the top would be alike.

Have you read Mr. Cachin's Report on the breakwater at Cherbourg?—No.

Are you aware that in the course of a long action of the sea, the slope of that break-

W. Cubitt, Esq.

18th June, 1844.

water, and the slope of the breakwater of Plymouth likewise, have been reduced to much longer slopes than were originally intended?—Yes; but below water they will not get so flat.

Then is there not a certain degree of slope corresponding to the degree of exposure to the action of the sea, which is peculiarly adapted to resist that action, and to which slope the long-continued action of the sea ultimately reduces any profile that may not be adapted to resist that force?—If we take any material like sand or small stones, or anything which will take a form from the action of the water, and constant action will produce a given form; but if there comes a different state of circumstances, like great storms, and so on, that will change the thing again; therefore there is no one answer that can be given to the question to fit all cases.

Are you aware that huge stones were displaced at Cherbourg?—Yes; which stones would not have been displaced if they had been laid on a good surface with a good joint. The wave which gives the impulse for a time on the stone, is as much as the weight of the stone; that is, if the wave is three times as deep as the stone is thick, and there is a little hole communicating with the under side, so that the effect of the wave could be communicated to the bottom of the stone, the stone would jump directly,

So you think that, notwithstanding that well-known natural effect of the action of the water to reduce the slope to a state of stability, you could construct, by the means you have stated, a breakwater with a vertical slope capable of resisting and enduring that action?—To be sure; because it depends upon an entirely different principle. If we build a wall with good joints, so that thewater cannot get in, there will be no tendency to throw the stones one off the other; and the weight of the whole mass being greater than the water, there will be no tendency to lift the whole.

What description and size of stones would you think necessary?—Any size for solid work; and I should say the larger the better. But, to answer the question in extremes, I would observe, that you may build as good a breakwater with blue Staffordshire bricks and Roman cement, of the best quality, as you could with the largest stones; and, as to expense, it would be as cheap as stone. The size of the material does not so much signify when the work is of a particular kind; but when I was asked about the forms the beaches and slopes will take, we must think of them either as solids carefully built, or as masses thrown loosely together; and the same answer cannot fit both.

What precautions would you take with respect to the foundation, so that these breakwaters, constructed by means of caissons, shall be sunk, and so placed that no dislocation as far as it can possibly be obviated, shall afterwards take place?—I will state a case in point. Opposite Dover, when you get into 6, 7, or 8 fathoms of water, the bottom, if you could see it lie dry, would be, to all intents and purposes, as level as the floor of this room to look at, and quite good enough to ground any well-built flat surface of solid matter on it to the size of 50 feet square; and that you might build and ground cubes of 50 feet, one after the other, and build them full up to the top of low water perfectly solid, I have not the slightest doubt.

As you are building on an inclined plane, how do you secure their being upright?—The inclination is so exceedingly small, that you would not perceive it if you were standing upon it. It is not so at the beach, but when we get out we find it as level as the floor; and although you get into six fathoms, and then, after a time, into seven fathoms, it is so exceedingly flat, that if you put a cube on it, the inclination is so slight that it would not be discovered by the eye.

Is that the case everywhere but just west and east?—At the west end, approaching the shore, the inclination of the beach would be greater, and there we should drive piles, or pursue other usual means; but all my remarks of late in building have relation to building an insulated breakwater far out at sea in seven fathoms water.

Are you, on the whole, prepared to give your opinion or advice as to the description and form of the section which you would recommend for a great national work of this description, and will you state what process of execution you would recommend so as to combine economy with celerity of execution, solidity and stability, and the nature of the materials you would employ?—In answer to one-half of the question, I would refer to my report to Mr. Baring, that is, as to the celerity and economy, because my subsequent experience has not taught me anything better combining all those requisites. But to leave economy and go a little more to expense, I think the best thing of all would be a solid stone breakwater or pier in the sea, built with an upright face, smooth and nice from the bottom to the top, and made quite solid. I think that would be the best thing.

By caissons, you mean?—Yes, the caissons being merely made the *modus operandi*, or the way of doing a thing which could not be done without them, because we could build them in short lengths, and sink them so nicely that they would form a wall 50 or 60 feet thick, and 50 or 60 feet high, as long as you please, and everything that was done would be complete in itself. The great object of this particular plan is to produce celerity.

(*Lt.-Colonel Alderson.*) Will you state what time would be required for construction?—I think three years would, to all intents and purposes, form the harbour with caissons in 100 feet lengths, and I gave an estimate of it; and that it would take 10 or 12 years more to complete the rubble stone outside altogether. I think in 15 years a good harbour would be formed.

Do you mean to state that a breakwater constructed according to the profile stated in your letter to Mr. Baring would cost 1000*l.* a running yard?—No. I must answer that more definitely, because, in speaking of 1000*l.*, I took the average of breakwater construction in seven fathoms water, and so I stated. The average cost of constructing the best breakwater in seven

fathoms would not be found to come much short of 1000*l.* a-yard. I believe that I could build one of solid stone for 1000*l.* a-yard, and I will give you my reasons. I will take it to be 60 feet high and 50 feet wide; 60 times 50 is 3000 square feet of sectional area: one yard in length of that would cost 900*l.* at 2*s.* the cubic foot. We could build the caisson, and build it full of the best brick and cement, or stone and cement, for 2*s.* the cubic foot.

You would not build the whole of solid masonry?—Good bonded rubble. I would engage to build the whole at 2*s.* per foot. You could do this thing in seven fathoms water, from 40 to 50 feet wide, perfectly upright. I have no doubt the price I state, 1000*l.* a lineal yard, including everything, would pay every expense.

Including the building of caissons also?—Yes.

(*Lt.-Colonel Colquhoun.*) Will you give us any idea of the time, the maximum celerity?—As to time, it is a difficult thing to state; but there is this merit in the thing, if there be no other, that you could have as many caissons getting ready as you chose; and in every summer, so soon as from the state of the weather you could tow them out and sink them (which is a very short operation), you could get on.

How many of these cubic masses would you deposit in the course of the summer?—I cannot say.

For the sake of your own work, would it be desirable to get on as fast as possible?—Yes. A good deal depends on the mode of setting about the thing.

And a like time for preparation?—Yes.

Will you state the maximum celerity by the caissons?—It is a difficult thing to answer; but I think I could do from a quarter to a third of a mile in the year.

(*Chairman.*) You have said that you prefer a close harbour to a breakwater?—Most assuredly.

Are you aware of the immense quantity of shingle that now travels from the westward to the mouth of the present harbour at Dover?—Yes.

Would not the harbour, if closed to the westward, prevent that shingle entering the present harbour, and the intended one also?—Yes. I had a particular scheme, if I may so term it, for keeping the shingle out of the new harbour; and that was, if the breakwater, or if the main pier lies in six or seven fathoms water, I would then have carried a sunk caisson of solid work, two fathoms high, across the bottom of the opening as a threshold. If the stream of tide was strong enough to draw the shingle along at the bottom, it could not float it in; and the waves would not take it up, because they cannot take it up at seven fathoms water.

What distance from the shore would you have that?—On this plan there is a design in red for a large close harbour with an entrance to the south-eastward, for instance, 1000 feet wide, and in seven fathoms of water. Five fathoms would be enough for the largest vessel to go over at dead low water. The thing being made, the harbour with its open mouth down to the bottom, and everything complete, the shingle accumulates to the westward. The shingle would accumulate till it began, probably, to gather round to the southward in front of the harbour, and would stream, along with the tide, along the front of the breakwater, and would have a tendency to get into the entrance; but I propose to prevent it by putting a threshold at the bottom of the entrance 12 feet high, which may be described as being exactly like a threshold to a door. If the tide be strong enough to draw the shingle along in a stream at the bottom, it could not draw it into this harbour, but would draw it past, and shingle is never lifted by the waves, I believe, more than three fathoms deep on our coast; therefore it would be beyond the reach of the waves at the mouth of the harbour in seven fathoms, but not beyond the stream of the tide, and it would be carried past it instead of going in.

Would it not be very easy to prevent the shingle from accumulating at the entrance by having two or three cones outside, and so by that means draw the shingle into deep water?—No.

Do you not think the sill you spoke of would meet the breaking sea in a gale of wind at the entrance?—No, not at that height.

Would not the sill, if constructed, be a mud-trap for whatever was inside, and prevent its escaping out?—No; because there would not be current enough in the harbour to carry anything out.

Have you any reason to believe that the silt would increase more at Dover from the intended harbour than has been the case at Kingstown?—Yes, a thousand times over, I dare say.

Will you state your reason?—Because I think while it would accumulate to about the thickness of a sheet of blotting-paper at Kingstown, it would accumulate some few inches at Dover.

Did you ever hear of silt increasing where there was shingle?—Yes; it increases in Dover Harbour to the extent of several inches per annum, and it is continually being cleared out. In Folkestone it has deposited nearly a foot since it was cleared out.

Suppose the harbour to be a closed one to the westward, and it was found that silt did increase after some years, might it not be very easy to open such a passage as you describe, and allow the tide to pass?—No, it would not be easy at all, and the passage would require to be so wide that by the time it became necessary to do it the silt would have got so hard that you could not open the passage wide enough to produce the effect.

Are you aware that it is supposed not to be good holding-ground in a part of the intended harbour at Dover?—Yes; but I do not mind that, because if there is not good holding ground good moorings can be put.

Would not that silt greatly increase the anchorage in the new harbour?—No; because it would be stiff enough to do a great deal of harm, and not enough to do any good.

(*Admiral Dundas.*) Suppose it was necessary to form a breakwater without delay,

W. Cubitt, Esq.

18th June, 1844.

and Government had twenty old ships of 100 feet long, could it not be done by building on those ships in the same manner that you proposed doing with the caissons, in a case of emergency?—In a case of emergency you might, and still the water, and put big stones into it, but it would be a bungling job altogether. A ship is the weakest kind of thing to do that business, whereas the caisson is the strongest thing. The frame of a ship is the best thing to float, but not the best thing to lie still and have the action of a heavy sea against it.

You said the caisson would last 15 years?—Yes.

How long do you think an old ship would last?—I consider that if it lasted 15 years it would be long enough for my purpose.

Do you consider that an old oak ship would not last 15 years under water?—Taking wood as to durability, it might last three times that period; but taking wood as holding together, it would not last at all, it would go to pieces.

What do you fasten your caissons with?—The caissons shown in the report are fastened with iron. The form is absolutely such as to be the strongest possible in which timber can be framed, that is, with three sides. There is nothing so strong when standing on its base, either as a frame, or a form to resist the action of the sea tide, which can be covered and supported with rubble stone to form a breakwater.

What is the price of each of your caissons 100 feet long?—About 6000*l*.

Would not a second entrance to any harbour formed off Dover, for instance, be the means of admitting a current through it, and thereby prevent the deposit that you seem so much to apprehend?—No entrance, as an entrance, would be sufficient.

An entrance to the eastward?—It would not induce current enough.

Would it not, in some measure, prevent the deposit which you seem so much to apprehend?—I think not.

Supposing there to be a principal entrance, and also a second entrance, do you suppose the second entrance would not be the means of admitting a current, and thereby prevent the deposit?—No; the current would not be at all sufficient; there would be a very slight draught between one entrance and the other.

(*Lt.-Colonel Colquhoun.*) As regards the tidal current produced through the harbour, whatever the width of the principal entrance might be, would not the velocity of the current be controlled entirely by the smaller entrance; would not that measure the velocity?—The smaller entrance would be the measure of the velocity, and it would require a considerable portion of velocity of the tide itself outside to keep the harbour clear inside; therefore, except the entrance was as wide as the whole harbour, you could not get the whole velocity; and in proportion as it was less than the whole harbour, you would get a small velocity.

Then, much as you prefer a close harbour for convenience, we are left to the only alternative of having a breakwater in front, according to your notion?—It is a choice of difficulties. That a difficulty does exist of silting up in a close harbour I do not feel any doubt.

(*Mr. Walker.*) As you have referred to the milky appearance of the water opposite Dover, and the silt with which the water is charged, do you or do you not consider that that has lately been caused and increased very much by the sea washing the loose chalk that has been thrown from the cliffs, for the purpose of forming the tunnels and the railway between Folkestone and Dover?—I have not the slightest doubt, that at the time those works were going on, that was in some degree the cause; but I have also known the water before that happened as milky as I ever saw it at that time; and I have also, since those operations, seen it the same. Also, that the great falls of the cliffs themselves, without any regard to the railway works, have caused more debris than all the railway works put together; and they will do so again except where we can prevent it. The point of Shakespear's Cliff will, whenever it falls, produce that effect in a great degree; and one fall from that produces more of it than has even been done in two or three seasons of the railway works. A great portion of the cliffs are protected from coming down altogether. The works may have caused some during the time, but that it existed before and exists after I have not any doubt at all, because I know the one fact and believe the other.

(*Sir W. Symonds.*) The questions which have been put to you have related principally to Dover Harbour?—My answers have principally been with regard to Dover Harbour.

I wish to put a question to you with regard to Dungeness. If a pier-harbour was formed along the coast of Dungeness, would it be liable to silt up as you have stated at Dover a close harbour would silt up?—No, the tide having a free current through it, it would not be so liable to silt up; and the very reason why I proposed to form a breakwater protection to Dover is, that it should not silt up.

Then do you mean to say it would be the same at Dover or at Dungeness by having a breakwater?—I do not say that the tendency to silt up at either place would be the same; but I say a breakwater in any place with a free tide-way between it and the land would be less liable to silt up than a close harbour at the same place.

(*Chairman.*) Are you aware what might be the effect of the shingle in a place of that kind?—It is a very shifting point, and keeps growing out continually, and it is not for me to say what effect the silting in one bay would have in preventing the shingle running.

Does shingle run in seven fathom water?—The point has moved out to my knowledge, and the deepest water is close at the point.

Might not the breakwater there have the effect of preventing that elongation of the point?—I am free to confess I do not know. I have not a sufficiently fixed opinion to venture to answer what the effect on this point would be, knowing its shifting nature. I infer there is an eddy tide in both these bays from the very shoals which are formed in them.

Can you imagine that a breakwater formed along the coast would not possibly have

W. Cubitt, Esq.

18th June, 1844.

any effect on the shingle moving towards the point on either side?—Only when it comes near enough to the shore to prevent the action of the wave moving the shingle. The shingle moves along this coast by being lifted and disturbed by the wave, and shifted to the eastward or westward, according to the prevailing wind.

Independent of the action of the tide?—Yes.

Would you recommend a breakwater to be placed in a situation of that kind with so great a shoal in front?—No, except you can get it further from the shoal; but the instant you get beyond the two or three fathom line it goes suddenly down. The questions arose as to silting, and I still say, whether you take it at Dungeness or take the question generally, that a breakwater outside, with a free tide-way between it and the shore, is not liable to silt.

Does that apply to every place?—It does.

Upon the whole, with your knowledge of the port of Dover and the inconvenience from silting up, do you prefer a breakwater admitting of delivery as much as possible of the stream of tide or a close harbour with two entrances?—As a harbour, if it could be kept clear, a close harbour. It is altogether a matter of doubt. I doubt if it could be kept clear; I think the deposit would accrue fast.

Could not the breakwater secure it from the other evils of motion; would it not make it a quiet harbour?—Quietness in a harbour in these cases is altogether comparative. An entirely quiet harbour is a close harbour. A roadstead is an open harbour, but quieter than an entirely open sea without any protection; therefore it is all a matter of degree. We might take, for instance, Yarmouth Roads or Plymouth Sound.

(*Lt.-Colonel Alderson.*) You have stated that an upright wall would be the best to form a breakwater?—I think it would if built in the best manner and upon a good foundation.

And that a long sea slope has a very much larger sectional area than any other mode of building a breakwater?—Yes.

What is your objection to forming a base of rubble stone to within a few feet at low-water mark, filled in with concrete as you go on by throwing concrete down and building upon that an upright wall, from four feet, say, below low-water mark at spring tides as high as you want to go?—Because I do not see clearly how such a proceeding would answer the purpose In the first place, putting rubble stone down to the bottom and concrete amongst it, would be a very difficult proceeding; and I do not think it could be made to answer the purpose in a sea where there was constant motion. Except we could get the concrete in solid masses and in enclosures it would not do; and even with that it is not quite the thing to stand the work of a heavy sea. We could not make a good bottom in that way. There is a heavy sea towards the top. Near the surface of low-water is where the action would be; and that would be exactly at the place where we should want the wall to be the best as the foundation for the superstructure. If you resort to rubble at all, it had better be all rubble work; or if you resort to masonry, it had better be all masonry.

Are you aware that you can build on rubble?—I believe the lighthouse at Plymouth Breakwater is built on rubble, but that stood many years before they made the foundation.

Are you not aware that they are building at the present moment at Cherbourg an upright wall upon rubble?—I am not aware of it; I believe that may be done. If a rubble wall has been in the sea, and stood 10 or 20 years, I think it might get solid enough for it.

(*Chairman.*) The subject of a breakwater to enclose Portland Road having been under the consideration of the Commission, you are requested to examine the sketch put before you, and to state your opinion of the same, as regards the direction, and the materials and form you would recommend to be adopted at that place?—It is a very good place for a harbour. I think Portland Road is one of the finest places in the kingdom for an asylum harbour.

What direction do you think the best?—I think the direction has less to do with it than any one would imagine; if you fix the place for the outer end, and if you fix the depth of water for the outer end, it matters little whether the breakwater comes to one point of the shore or the other; it is the simplest case of all harbour making is this Portland Road.

In constructing a breakwater at Portland Road it must necessarily be of a considerable length. Do you think an entrance in the middle or near the shore desirable, in case of the wind blowing hard from the northward; might not vessels find a difficulty in getting out round the north end of the breakwater; or in case of parting their cables, might they have facility of escape instead of foundering on the breakwater?—I think it would do no harm to the harbour, and it might do as a means of exit.

Can it always be filled up if found inconvenient?—Yes, and it would not be large, because it would be to get out and not to get in by.

Would you have in that case two openings, one near the shore and another in the middle?—No; I think one about one-third of the length from the shore would be the best place; it would be suitable for an entrance, and would combine the advantage of one in the middle and one close to the shore, in a great degree; and it would be the cheapest way to make a harbour there, as there is plenty of stone, and all down hill for the run; it would be a pier, and rubble stone continually run in until it was made.

In order to leave an opening, but still get the advantage of running rubble stone out, do you not think piles and a stage built across would be desirable to complete it?—I think we could construct a frame that would carry the waggons; and I think it would be a most beautiful harbour. I have looked at the place as a fancy harbour-maker occasionally, and thought it was a very good situation for one.

With reference to the plan before you of the breakwater at Portland Road, do you see any objection to have a second entrance, either with reference to expense or the difficulty of building it?—I see no objection to a second entrance.

W. Cubitt, Esq.

18th June, 1844.

I understood you to say, that having it one-third out, it met both points?—Yes.

(*Lt.-Colonel Alderson.*) And would prefer a breakwater of *pierre perdue* entirely?—Yes, it is suitable for it.

Do you not face the other slopes of the breakwater between low and high-water mark?—I take that for granted in all cases of rubble breakwater.

Then you think the sea would not interfere with that by having a rubble base?—The general practice is to form the whole of the breakwater with rubble stone up to the full height, and then let it take some years' trial to see how the stones will get settled together, and after a time, again to regulate and pave in among those to make a uniform sort of slope on the outer face after it has got settled.

Would not an entrance of any size cut through the breakwater enhance the expense of the breakwater?—Yes.

Do you think that the expense of building a stage to fill up the space would be greater than the expense of constructing the breakwater in that space?—Yes, that adds to the to the necessary work which must be done at the pier-heads.

Would it not expose the bay to the incursion of the sea?—No, because I stated that it would not require a wide entrance there for vessels to get out occasionally.

How wide would you make it?—200 feet, or 250 feet.

(*Chairman.*) If there was an entrance sufficient for vessels to go out at, do you then apprehend it would endanger the ships from the incursions of the sea?—No, I think not, because the surface in the mass of water, behind the breakwater, is so large compared with the opening, and knowing there is an entire opening, miles in extent, at the end, I do not thinki t would have an injurious effect on the vessels at anchor.

Do you consider the attack of the worm an objection against the use of limestone?—It is an objection, no doubt, as far as it goes; but I think it a less objection to keep up the breakwater made with that stone, which is so much cheaper than it would be to make it with any other stone which the worm would not touch. I would feed the worm rather than buy a dearer stone. The Portland stone is so cheap that you could better afford to make two breakwaters in Portland Road in 500 years than bring stone from Guernsey to make it with.

Suppose it to be desirable to improve Newhaven, are you prepared to give the Commissioners any plan as to the best mode of carrying it into execution, in order to increase the capability for receiving armed steamers, and for the more easy access of merchant-vessels seeking shelter there?—It is a very difficult subject that of Newhaven, and I have no satisfactory opinion in my own mind about it. I think that whatever be done there, with a view to a deep-water entrance, may never be wholly worth its cost; because, with very little or no expense, I suppose from four to six feet may be maintained at low water, and it will take very great expense to get more than 10 or 12 feet at low water, if you maintain it. It is a very long way, 500 yards, into two fathom water.

Putting the expense out of the question, should you think it a desirable plan to adopt to lengthen out the piers so as to get into 12 feet water?—That is the most certain way of getting out into 12 feet water.

Would you widen the entrance in carrying out the piers?—Yes, I should make it wider certainly than they are at present; I do not see why one of the piers, the eastward one for instance, might not be carried further from the other in approaching the shore, and the westward pier carried to the east, so that the set of the ebb-current would hug it close.

Now, if you open it to any great extent, would it not diminish the force of the current of the egress water?—Supposing the eastward one is widened next the shore, I should make the other with a sweep. I believe it will keep as deep water close along side the curved pier as it would between the two straight and parallel ones.

Where would you carry this to?—To the shore to protect all that difficult part of the coast.

The moment the water escapes the narrow part of the channel, would it not expand and lose all its strength outwards?—No; it would not be empty. All this part would be filled with water, but the current would run close to the pier.

Would it not, when it came past the eastern pier, have a tendency to expand and become more feeble in its duration?—No; if we take the bend of any river whatever, we always find deep water on the concave side.

You would propose, then, a pier or groin reaching to the shore?—Yes; so that high water would not go over it.

How in that case would you leave the present eastern groyne?—The present eastern pier might in that case come up. I think you might always maintain as deep water within side as you could get out, which is all you want.

Are you aware of the great mass of shingle inside the eastern pier?—No; I am not aware of the accumulation of shingle there. I used to know a great deal of this harbour at one time, and the great difficulty we had was to keep the beach; and I think since I have known it the parties have put down the groynes to keep it there.

I think you stated that, in the event of carrying out a pier or breakwater in the line you suggest, you would take away the eastern pier?—Yes.

How far?—Up into the river.

How far into the river would you take it away?—To the whole extent.

Would you construct anything further back?—Make it a good river channel.

Without constructing anything?—Yes, as this would be a comparatively narrow entrance, and no heavy sea could roll in at all.

What breadth of entrance would you have?—Not more than 150 feet, or from that to 200 at the utmost.

W. Cubitt, Esq.
18th June, 1844

Would you not give at once scope enough to meet all the risk of an awkward ship coming in yawing about?—Then you will not keep the shingle away from the mouth of it; you want the jet of the ebb-current to have as much effect as possible.

Then the whole expense of your improvement would be simply the pier or groin, and the removal of the eastern wall?—It would be some 30,000*l.*, I suppose, or from that to 50,000*l.*

Do you consider the removal of the eastern pier as an essential point?—I think if an eastern pier were put in direct from the shore, all the minor eastern works might be taken away.

Would you recommend them to be taken away as an improvement to the harbour?—Yes, because there would be a bet er outlet for the current, but it must always be combined with the west pier curved to the eastern.

(*Captain Washington.*) Why must it be curved?—It would not otherwise keep a uniform channel.

Are you aware that the outset at Newhaven is very great at present?—Yes.

Do you contemplate dredging the harbour to the same depth as the entrance?—I should dredge and improve the channel upwards to the bridge.

(*Chairman.*) Do you recommend anything being done with Sleepers' Hole in order to procure a greater power of back water?—No; it would be throwing away money; that has silted up more than 10 feet to my knowledge.

In how many years has it silted up 10 feet?—Perhaps 20 or 30.

Do you think if it is lengthened out on the plan you propose, it would be desirable to try to obtain any greater rush of back-water?—The best means to obtain a rush of back-water is to improve the channel of the river up to the town. I should improve the channel; I do not recollect exactly the form, but I have speculated some years ago of straightening the channel past the town. There is a bad bend by the town. If the harbour was ever improved at the mouth, I would straighten the channel from the mouth up to and past the town.

Looking to the possibility of a breakwater being constructed in the front of Seaford or near Newhaven, and the possibility of requiring this harbour for large steamers, do you think it might be desirable to excavate by Mr. Catt's marsh-land for a basin?—I think it might; but if a harbour were enclosed off this coast, it would be a doubtful point whether the river ought to run into that. If the river was taken to the westward of it, it would make a good entrance into the harbour; and then the question is whether the new harbour would not silt up.

Would you think that applicable to a simple breakwater?—Not to a simple breakwater with open ends. The best thing to do with Newhaven is to improve the channel to above the town, and to make an extended pier into two fathom water.

Supposing a dredging-vessel to be employed merely with buckets to lift up the stuff, and passing round and round, would not that have the effect of clearing away without the great expense of loading and unloading barges?—Yes; that would be one means of tending to keep the thing clear of light silt.

Of any description of stuff?—To do that you must make the whole of the water, during the whole of the ebb-tide, more turbid than when it entered on the flood, that is, make a little more mud go out every tide than came in; on the same principle that they keep water in boilers from getting too salt; and that would be trouble and expense.

Of course this is an operation that would only go on in a falling tide?—Exactly so; but when we come to acres and hundreds of acres, it is a very difficult and expensive operation

(*Captain Washington.*) Would not Sleepers' Hole be space enough to form a basin, if required, for refitting steamers?—Yes, a very useful dock might be made in Sleepers' Hole for the purpose of re-fitting.

(*Chairman.*) Have you any knowledge of Harwich Harbour?—Yes.

Are you aware of the state of Harwich Harbour?—Yes, I am aware of its general state; that the one side is going away, and that the other is going also; thus making both sides shoal, and spoiling the entrance by contrary operations.

Are you aware of the great lengthening out of Landguard Point?—Yes.

To what do you attribute the elongation of the point so rapidly?—First, from the extension of that part of the coast to the southward; and, next, the working away of the opposite shore; and thus widening the mouth, if I may so term it, of the entrance.

What is the cause?—The prevalent winds and the flood-tide both act in that direction.

Are you aware of a considerable shoal off Felixstow having been removed?—I do not know the special case, but I know all the cement-stones on that coast have been attacked by cement-makers.

Do you think groins would be desirable run out on this shore?—No, I do not think that would do so much good as doing something like what is shown in pencil on this plan.

What would you recommend to be done to improve the entrance to the harbour?—Put out a pier on the Harwich side from Beacon Cliff to Cliff foot Rocks.

Would you have a breakwater to shelter the foot of the cliff?—I would have the Beacon Cliff form the inner end of the breakwater—to groyne from it, as it were.

And that is the direction you would give it?—Yes.

Do you think that breakwater would cause the tide to act on Landguard Point, so as to increase the beach?—It would have a tendency to do it.

Does it not, according to the line given now, go too much without it?—I do not think it does; it is all shoal water below the point. I think a few yards more or less either way

W. Cubitt, Esq.
18th June, 1844.

would have nothing on the general effect; the general way would be to make the best channel into the harbour. The points I have mentioned appear from the chart to be the best, that is, that they terminate in rock, because if turned further into the harbour it would not have the Cliff Rocks to end on.

(*Lt.-Col. Colquhoun.*) How far did Landguard Point extend out when you first knew it?—Close round the Fort.

How many years ago?—About 40 years ago I first knew it.

How near the top of the glacis?—That I cannot precisely charge my memory with; but I think it was less than 100 yards.

Is there anything else you would suggest for the improvement of this harbour?—Remove all shoals and put up a good breakwater; a good deal might be done internally.

You would remove shoals in the way of free passage?—That is the first and great concern, I think.

Are you aware that down at the Lower Lighthouse terminates a very solid wall of the Ordnance, and that it was suggested to make the breakwater abut there, and come off in such a direction as to be a continuance of that sea-wall?—I did not know the object of it, but I prefer the extension of Beacon Cliff to Cliff Rock, in preference to the long curve from the lighthouse.

(*Captain Washington.*) Do you consider these measures essentially necessary for the preservation of Harwich Harbour?—I think something is essentially necessary for the preservation of Harwich Harbour.

And what you have stated you consider to be the best?—Yes, I do; a straight pier from the Beacon Cliff.

Do you recommend a general dredging of the channel?—Yes.

Are you at all aware of the expense of dredging the shoals?—I am aware of the expense of dredging generally; the shoals I take to be clay; I should say the expense would be 1*s.* a cubic yard.

(*Chairman.*) In the Report of the Harbour Commission of 1840, of which you were a member, a decided preference is expressed in favour of Dover for the construction of a harbour; are you still of opinion that for the convenience of the trade, and as a station for armed vessels of war, it is the best position along the south-east coast?—I am decidedly of opinion that, taking all circumstances into consideration, Dover is the most proper place for such a harbour; and I am also of opinion that a harbour may be so constructed in Dover Bay as to obtain all the advantages of which the situation is capable, without letting in any of the evils to which it is more particularly liable.

[*The Witness withdrew.*]

Wednesday, 19*th June*, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Jesse Hartley, Esq.
19th June, 1844.

Jesse Hartley, Esq., examined.

(*Chairman.*) In what situation are you employed?—I am the engineer to the Liverpool Docks.

Have you ever been engaged in the construction of breakwaters?—Never.

Have you constructed piers or sea-walls in exposed situations?—Yes; I have had experience in the construction of such works.

Suppose it to be decided to convert Dover Bay, Dungeness, or any other place into a harbour, with a sea front in seven fathoms at low water, having regard to economy and speedy execution, so far as the same may be consistent with the solidity and permanence of the work, will you give to the Commissioners your opinion as to the mode and the materials for constructing such a work?—I do not feel that I could do so without having some knowledge of the situation and the neighbourhood in which such a work was to be placed; a great deal depends upon the locality in obtaining the materials, a very small material may be made to answer the purpose very well, where larger materials cannot be obtained, and perhaps would come cheaper than larger ones.

Do you know the locality of Dover or Dungeness?—Not particularly; I have been there.

You do not know the localities sufficiently to give an opinion upon them?—No.

Considerable doubts being entertained as to the slopes, and particularly the sea-slopes of breakwater the least likely to be damaged by the action of the waves, you are requested, on reading Colonel Jones's paper on this important subject, to give us your opinion?—I have read his paper, and it perfectly coincides with my own ideas generally upon the subject, the principle I perfectly agree with.

Will you state what the principle is?—To make a stronger and more efficient work by the present mode of construction than is at present used. I go all the lengths, and perhaps a little farther than Colonel Jones does.

What do you mean by going a little farther?—I would have a greater quantity of upright wall.

From the base?—Yes; I would make the base considerably broader; nature forms lines in all material that is thrown into the sea according to the nature of the ebb,

Jesse Hartley, Esq.
19th June, 1844.

and the quantity of wind it forms, a natural section which it is always necessary to follow. I think that particularly as to the bottom part, but even as to the upper part, the more perpendicular it is the better it would stand.

Between low and high-water mark?—I would go below the surface of low-water mark; considerably lower—as far as I could get.

By what process would you construct such a work by caissons?—That entirely depends on the material which you have to use; if you get very large blocks of stone, such as we get near Liverpool, you can lower them down easily; in other cases, where you have a small material (which perhaps if you get the right kind of material is better even than large stones), you would sink them in caissons.

What is the largest stones which you use?—We can get them of any size.

Practically speaking, what is the largest size?—About 10 or 12 tons.

Of what description of stone?—Sandstone.

In using chalk, which is a material that abounds on the coast of this part of the country, would you use caissons?—In such a case I would use caissons.

In constructing caissons, would you make use of wood or iron?—Iron would be preferable, if you could meet the expense.

What do you imagine would be the difference of expense between wood and iron in a length of 100 feet?—I do not suppose there would be much difference.

The iron would have greater durability?—If the thing was properly constructed, the iron in its decay would create a durability in the material.

You would prefer iron for the caisson, except on the point of expense, in which you say, however, that you do not think there would be much difference?—Yes; I should not make caissons; I should make large chests or boxes which should be lowered into their places.

Of what description would you make them?—Much would depend on the material; perhaps they might be 20 feet long and 10 feet wide; the dimensions, of course, must vary according to circumstances; you might make the chest of any dimensions; you might have them as heavy as you could lift, with two floats, and lower them into their place exactly.

Would not boxes of that size be very apt to be moved by the action of the sea?—I think not, if they were properly managed; it depends upon how the work is carried on.

The weight of a box of that kind does not seem sufficient to keep it in its place?—The weight of a box of that kind would be 50 or 60 tons.

Would it be 60 tons without the iron?—The dimensions must all vary according to circumstances; some would be wanted large and some small, they would vary very much; a great deal would depend upon the nature of the bottom.

Are you sufficiently acquainted with the south-east coast, and sufficiently in the habit of forming or examining breakwaters to give an opinion to the Commissioners as to the best form for them?—I never yet have seen a breakwater which I thought was built as it ought to be.

Will you have the goodness to state what you believe would be the preferable form for constructing them?—Without being on the place for some time, I could not give an opinion on that. I consider that a breakwater should be so constructed as to keep itself free from accumulation.

You mean that no accumulation should take place inside?—No; I consider that a breakwater should be so constructed that ships might enter and leave it at all times, and that there might be a self-acting scour or current through it.

By keeping a wide opening at each end, and merely having a breakwater in front, would not a considerable sea come in at each end in most situations?—Yes; a great deal depends upon the locality of course.

Your object in having it in that way is to prevent accumulation; to give the tide a fair run through?—Yes; a fair run through.

You are understood to object to all harbours that you have hitherto seen?—I have not seen one that I thought was what it ought to be.

Have you seen the Plymouth breakwater?—I have.

Do you approve of that?—It is many years since I saw it; I do approve of it as a breakwater, because it can be approached at any time; but it appears not to keep itself free.

You approve of its position, but not of its profile?—It is a sort of thing that I should prefer to an enclosed structure. In 1824, I think the plans of General Bernard for a breakwater in the Delaware were sent to me for my opinion. I objected to the plan, and gave the parties my reason for the objection; but they only carried it partially into effect; and in consequence of their not carrying it fully into effect, it is now silting up.

What was that plan?—It was a straight breakwater, with two others at a distance from it to break off the ice, but still to maintain the current.

In what depth of water was it?—I think about 22 feet at low water?

At the front of it?—Yes; the slopes were very much like the Cherbourg breakwater; I see that Colonel Jones states that they are upright, but they are not so; they are pretty much the Cherbourg slopes.

You have described the Delaware breakwater as consisting in fact of three breakwaters?—Yes; the Delaware breakwater, which I recommended, was three breakwaters, a front breakwater and two others. One was placed longitudinally and the others across the end of it.

The breakwaters do not join to the shore?—No.

Jesse Hartley, Esq.
19th June, 1844.

Will you describe what was the alteration which you suggested in the Delaware breakwater?—Mine was an alteration of General Bernard's plan; I objected to it on account of the elbows at each end.

Those elbows were not at the front of it?—No.

If you were called upon to construct a breakwater, the Commissioners gather from your evidence that you would have it in front only?—Yes.

Without anything running off at the sides?—It would depend upon the situation; it might want some cover at each end, a short breakwater, perhaps, to prevent the sea rolling in, but that depends entirely upon the site of it.

Supposing your pier-head runs out into seven fathoms water, and shingle is brought into that depth of water, will it be swept away or will it remain?—I am afraid, in that depth of water, it would remain.

Do you consider that an old man-of-war, built in with stone is good as a caisson to form a breakwater?—You might make them as good, I think; but taking them in their present state, they are not so, because of the bilges; they would not stand upright; I think, however, that you could not have a better thing than something of that kind.

When the ship decayed, would it not fall over?—You could not make the masonry so close; you might put the masonry inside, but whenever the wood decayed, the openings that would be left would create a great deal of cavity that would be very objectionable. In iron caissons they would come so close together that there would be no cavity.

Would not that also be the case with wooden caissons of the same form?—They are never made tight to the masonry.

When you speak of upright faces, do you mean a vertical structure, standing upon a foundation previously laid, having a slope outwards, or in every case a vertical wall built upwards from the bottom?—I would build the vertical wall upwards from considerably below low-water mark; I should prefer it nearly upright, but rather inclining outwards; I would have it overhang a little towards the top, above high-water.

What is the foundation, and how do you propose to form it upon which you would erect that superstructure?—I would have caissons of iron and timber, and lower them down.

How would you proceed as to the foundation?—I would have each caisson adapted to the bottom.

Moulded to the bottom?—Yes.

How would you lower the caissons?—By means of two lighters.

You have said that large masses of stone might be used instead of caissons if that material were abundant?—Yes; only with caissons you can cover a larger space. Those stones are very difficult to get; but you may build caissons on the shore, and bring the materials there.

Where you have the materials on the spot you think that large masses of stone might be used?—They might be, but I am doubtful whether the other plan would not be a more speedy and economical method, if you can get the right kind of mortar.

At what rate do you suppose the profile required at Dover would be constructed?—I do not know.

Allowing every limit as to expense, what would be the condition in point of time; how many months or years do you think would be necessary to construct a mile?—I should say it might be done in about four or five years if there was no limit in point of expense.

In seven or eight fathoms of water?—Yes.

While one portion was going on, other portions could be proceeded with likewise?—It might go on in many places at the same time.

Have you any notion what the cost of a mile would be?—I have no idea of it; it would take a great deal of consideration before such an estimate could be arrived at. I think it very likely that the small granite would be as convenient as anything; that might be thrown out from the vessel into the caisson without going on shore.

Do you know anything of the effect of the worm on stone?—I know a great deal too much of it.

Whereabouts have you had experience of it?—At Liverpool it is a great nuisance.

In what description of stone?—It is not in the stone, the worm has not attacked our stone.

It does not touch the sandstone?—No, it will only take the limestone.

Does Portland stone partake of that quality?—Anything that has got lime in it the worm will touch, but nothing else.

That must depend upon the locality, because there are some places where there are no worms at all?—I was told, some years ago, that at Sheerness a 12 inches square pile of Baltic timber was eaten through in 12 months; but the harbour-master at Dover wrote me, about 20 years ago, that they did not know what the worm was there.

Wherever there is blue clay the worm is more destructive than anywhere else?—Yes, we have none with us; the greenheart timber they will not touch; we have pickled our wood with arsenic and all sorts of things.

Have you tried any of the African oak?—Yes; they will eat that.

And the teak wood?—Yes; they will eat that.

Did you say that at Dover there was no worm?—There was not at that time, 20 years ago.

Would you propose the employment of limestone in any construction under water at Dover?—Not in the front.

(*Lt.-Col. Alderson.*) You would case it with granite?—Yes, either with granite or basalt.

Could you form any sort of calculation as to the price of the caissons?—I could form a calculation and transmit it to the Commissioners.

Have you had much experience in the use of the diving-bell?—Yes.

In building?—Yes, a good deal.

Do you think that the foundations of the wall below low-water could be constructed better by means of the diving-bell than by lowering the stones and letting them find their level?—Yes, but it is more expensive.

Do you speak generally of any depth of water?—Yes; I think I would sooner trust to boxes, without any diving-bell.

At what depth of water are you speaking of?—Seven fathoms.

Do you use a dredging-vessel much at Liverpool?—Yes.

Do you load barges from that vessel, or do you merely keep it in motion to carry off the mud?—We load barges.

What do you do with the contents of the barges?—We throw it into the tide.

(*Chairman.*) Suppose on an ebb-tide, without loading barges, you kept whisking it up and throwing it out into the water, would the mud be carried out by the ebb-tide?—If the tide was sufficiently strong it would go away.

Are you acquainted with Portland Roads?—I never examined the situation of Portland. I have passed it.

Do you know Newhaven?—I am not much acquainted with any of that coast.

Will you look at the plan before you; supposing a breakwater ran out in the direction described in that plan, do you think any opening in such a breakwater desirable or not?—I could not give a satisfactory answer to that question.

Are you of opinion that a close harbour like that which is traced in this plan in Dover Bay would silt up very soon?—I should have a great objection to all close harbours anywhere; they all silt up very fast.

That is not the case at Kingstown, is it?—It is the case with all that I have seen. I should qualify my answer perhaps to this extent, that it depends to a certain degree upon the nature of the coast; if there is much sand or shingle, it is almost certain to fill up; where there is no sand to come in, it may do very well.

Are you acquainted with Kingstown harbour?—I have been in it twice.

Are you aware that that harbour does not silt up at all?—I am not aware of it; but there is no sand on that coast; it is all hard rock.

Will you name any harbour which you have known silt up?—I cannot at the moment call them to mind. Whitehaven, for instance, does.

Into which a stream runs?—I believe so.

Bringing down a great deal of detritus from the land?—Yes; the basins at Liverpool, outside the dock gates, silt up very much also.

Do the basins at Liverpool silt up from matter held in suspension brought down by the river, or brought in from the sea?—It is not brought in from the sea, it is all brought in by the river.

Do not you think that to be generally the case?—It is generally the case.

In all harbours that silt up?—Yes.

Are there not a great many ships lying in the basins at Liverpool from which things are thrown overboard?—There is nothing permitted to be thrown overboard; we keep too close a watch upon them for that. We had a dock run dry the other day, which had not been run dry for ten years, and I was much surprised to find it so clean, there was nothing at all in it, there was very little silt and no rubbish.

Had the sea-water any access to it?—Yes.

(*Lt.-Col. Alderson.*) As you know Dover, and the quantity of sea which thereis in Dover Bay, do you think that the diving-bell might be depended upon as a means of executing any large quantity of work?—I think it would never be done by a diving-bell in a place like Dover Bay.

From the quantity of sea?—Yes.

What do you think of large masses of brickwork built and carried out and sunk for a breakwater?—If you put brickwork together, of very hard-burnt bricks, you could have nothing better.

(*Lt.-Col. Colquhoun.*) Specific gravity is a great element of rest, is it not?—Certainly, basalt would be better than granite.

Do you know any instance of concrete having stood under water?—I should have no fear but the concrete made of Dover gravel, with our mortar from the Halkin mountain lime, would stand for any length of time under water.

Do you think that the artificial foundation which you propose, that is to say, caissons, whether of iron or timber, filled in with concrete, would bear the enormous weight of that structure of upright breakwater, and permanently resist the crushing effect that would be produced?—Yes, I think so, if properly constructed.

Notwithstanding what you have said with respect to the good quality of hard-burnt bricks laid in good mortar, would you recommend a brick face to be exposed to the action of the sea?—No.

Your observation with regard to bricks would apply to the backing only?—Bricks burnt on purpose I should have no objection to use towards the sea, but not a very small brick; I would have a very large one used.

[*The Witness withdrew.*]

J. M. Rendel, Esq.

19th June, 1844.

James Meadows Rendel, Esq., examined.

(*Chairman.*) Have you been engaged in constructing breakwaters?—I have.

In what place?—At Plymouth, Mill Bay Pier, just finishing in the Port of Plymouth, and on different parts of the coast.

Into what depth of water does that pier at Mill Bay go.—Forty-eight feet at low water.

Suppose it to be decided to convert Dover Bay, Dungeness, or any other place into a harbour with a sea front in seven fathoms at low water, having regard to economy and speedy execution, so far as the same may be consistent with the solidity and permanence of the work, will you give the Commission your opinion as to the mode and materials for constructing such a work?—To construct a breakwater in seven fathoms water is, I apprehend, a very formidable undertaking, especially if any of the ingenious contrivances of caissons and machines of that kind are to be resorted to. I doubt very much, if a breakwater is to be constructed in seven fathoms water, whether the only safe plan would not be to deposit in the usual way from vessels, if it is a detached breakwater, or from a railway, if it is a breakwater connected with the shore, and the shore produces suitable materials, a mass of stone up to within, say, two or three feet of low-water; and above that to construct perpendicular walls of the kind referred to in Colonel Jones's letter of suggestions. I do not know of any instance where a breakwater of the magnitude now contemplated has been constructed, and I do not think that a breakwater of that magnitude should be attempted by caissons, until the plan had been found to answer on a smaller scale. With reference to the particular localities referred to, not having made personal examination of them, I should not be prepared to give the Commissioners that decided opinion by which I should wish them to be at all influenced. It must be manifest to every member of the Commission, that in treating a subject of this sort, the nature of the locality of the materials to be used, and all the circumstances of the case should be known to the engineer, and he should have an opportunity of balancing those circumstances, and drawing out, as it were, a debtor and creditor account in such a manner as to enable him to arrive at a right conclusion.

You spoke of ingenious contrivances of late, what do you particularly allude to?—I mean those systems of building breakwaters in very deep water in caissons, which have lately been proposed by different engineers. I would first refer to that proposed by Mr. Cubitt for Dover, and then to that proposed by Mr. Bremner; those are very ingenious contrivances, and they would answer on a small scale, but I do not see how caissons of a magnitude suitable for seven fathoms of water are to be made, filled, floated, and sunk. I think it is a very formidable undertaking to attempt. I have myself had a good deal of experience in building in caissons. I have founded a bridge by caissons; those were only 60 feet long and 25 feet wide, and though they formed (having reference to the difficulties) the best mode that we could adopt for making the foundations, still I know, from the trouble we had with them, that they are very formidable machines of that magnitude only, in a rapid tide-way.

In what depth of water were those?—They were sunk in eight feet of water at low-water spring-tides, and we had 19 feet rise of tide. I should say therefore, as to building a breakwater with caissons, I should like to see such plan first attempted on a much smaller scale than in seven fathoms of water.

On what scale should you suggest?—That would depend upon the degree of exposure of the situation. If it were in a very exposed situation, I should not certainly like to be responsible for an attempt beyond three fathoms of water; I think three fathoms of water is quite a sufficient depth for the use of caissons in an open roadstead, on an exposed coast.

Having deposited them in three fathoms water, and found it answer, you would be tempted to go on?—Yes, if I found that, under all circumstances, it was the most economical mode of forming a breakwater; but I take for granted the object of adopting one plan in preferance to another is, to obtain a successful result with the least cost, and I think therefore that every situation must be dealt with in reference to its own peculiarities, and the skill of the engineer is as much called out in adopting a right system of execution as in making a right design for the situation.

You are understood to say, without reference to particular localities—confining the question to the depth of water anywhere—that if you found, after the sinking of your caissons in three fathoms, that they answered successfully, you would be encouraged to go to a greater depth—that you would have made a sufficient test to lead you gradually on?—I think if I succeeded in sinking the caissons in three fathoms water in a way to obtain a successful result with reference to the permanence of the work so constructed, and to its cost, I should be tempted to take another step, and go another fathom; and if still successful, I would take another step, and go another fathom; but as a practical engineer, knowing the difficulty of attempting anything new on such very large scales, I should not be disposed to calculate upon forming a breakwater in any of the localities named in seven fathoms water by means of caissons.

Have you used caissons in any other places than where you have just mentioned?—No.

How long ago is that?—It is about 17 years ago.

Are you aware of their present condition?—I believe they are perfectly secure; but the bed of the river in that case being entirely quicksand, the foundations had been previously prepared and enclosed by piles, and then the masonry was built in the caissons,

J. M. Rendel, Esq.
19th June, 1844.

which were used because we could not exhaust the foundation of water. It was impracticable; no coffer-dam we could have placed there would have answered, and we were obliged to resort to the caissons as the means of laying these foundations, or to the diving-bell; and on full consideration, I found that it was cheaper to adopt caissons; though afterwards, to expedite the work, we resorted to the bell also. The result of the experience I had with these caissons would make me seriously hesitate before I should undertake a formidable breakwater, in an exposed situation, in more than from two to three fathoms water in caissons as a first step.

Would you prefer wood or iron in caissons?—Most decidedly wood.

Would you cover them with scupper-nails?—I can only consider caissons applicable at all as the means of beginning the work or forming a nucleus for the breakwater; I hardly imagine they would be used where the material of the caisson was afterwards to form a part of the breakwater, I should therefore look at the caissons as the means of getting a nucleus about which I was afterwards to make my permanent work.

Have you described the nature of the slope you would give to a breakwater?—I have not.

Considerable doubt being entertained as to the slopes, and particularly the sea-slope of a breakwater, as least likely to be damaged by the action of the waves, you are requested to state, on reading Colonel Jones's paper upon this important subject, your opinion upon it?—I think Colonel Jones would be very likely to fall into the same error in universally applying perpendicularly-sided breakwaters as other engineers have been of universally employing sloping ones. In all these cases there must be a distinction, that distinction being drawn from particular circumstances; the nature of the material, the nature of the site, and all the local circumstances of the case which an engineer has to deal with; and I can no more imagine the universal application of perpendicular-sided breakwaters than the universal application of sloping ones; and he who would adopt either as his practice without any variation, would be very much like a person who thought one medicine suitable for every disease. I cannot imagine that you can lay down a rule that should invariably be adopted either for perpendicular or sloping-sided breakwaters. I believe, in most cases, a benefit will be found to result from the combination of the two; I think therefore that Colonel Jones is right in the principle he has adopted or recommended in this sketch, which is tinted red. It is all very pretty to show these stones here in the nice order of adjustment a draughtsman can draw them. I know from experience it is quite impossible so to execute it. You could not put in those stones with a diving-bell, at that slope; the slope must be flatter to get them in with a bell; and I know of no means by which you could get slopes of that kind paved as here shown. I do not think the breakwater is at all strengthened by having the stones adjusted by hand in the way here represented. I think if the stones were thrown in and allowed to form their own slope, that slope being determined by the nature of the materials up to within two or three feet of low-water, and then the breakwater raised upon that with perpendicular sides, it would be the most economical plan in most situations. But there should be a very considerable benching between the point at which the slope terminated and that at which the perpendicular breakwater began, otherwise the chances are that the perpendicular wall would be thrown down by the disturbance that always takes place in a work of this kind at the angular point.

You are acquainted with the Plymouth breakwater?—Intimately.

Do you approve of that structure?—I do not. I think the Plymouth breakwater has been a misconception, both as to the exclusion of small materials and as to the enormous magnitude of the mass of materials. I think the slope has been altogether more than was necessary; if a plan on the principle of Colonel Jones's had been carried out, I think there is a larger mass of materials than would have been then required, and you would have had the same result at a smaller cost. But I think, at present, all the ends that could be desired for the breakwater, as a fortification and a shelter for Plymouth Sound, would be accomplished by raising a parapet upon the present work, and preventing the sea from rolling over it in the way it now does, which is one of the causes of injury it so frequently sustains. The slope forms an inclined plane, up which the sea is able to roll the large blocks of stone which form what is called the fore-shore, and to throw them on the land side. This, I believe, is now pretty generally admitted. I would say, as to the Plymouth breakwater, that it is weak in comparison with what it would have been if the small materials that were rejected in the formation of it had been carried out and deposited with the large; and I speak with some confidence from the fact that I have had an opportunity of ascertaining the degree of solidity of that work; and I know that, even in its present subsided state, it is not solid by more than 32 per cent., that is, out of every 100 feet of mass 32 would be vacuities.

With that feeling, do you entertain any doubt as to the security of the lighthouse at the end?—No, because I think the foundation of that part of the work has had a long time to subside, and I think there also they have lately used, and indeed for many years past, small materials. But such is the fact generally; and you may easily ascertain it by taking sections of the work as it exists, and dividing the cubic contents, computed from those sections by the whole quantity of stone carried out. Now we all know that 13 cubic feet of the material of which it is built is a ton, therefore if you find that every ton carried out has filled 22 or 23 feet of space, you have, of course, the proportion of interstices. In the pier that is building in Mill Bay, by adopting a different plan, we have a different result. By carrying out the materials as they are quarried, large and small together, and depositing them at the same time, with the very same materials we have, if we take the whole cubic contents, and divide that by the number of

J. M. Rendel, Esq.
19th June, 1844.

tons, 17 is the result, which shows that the solidity of the work is as 17 to 13; and I need n say that solidity is a very important matter in determining the strength of the work.

In Mill Bay you have shallow water, would you recommend the same plan of proceeding in deep water which you are now following there?—We have 48 feet water in the last 100 feet of Mill Bay Pier at low-water.

(*Admiral Dundas.*) Suppose you are hurried to make a breakwater, in forming the nucleus of the breakwater in seven fathoms water, would it be economical to sink old ships filled with stone well cemented together, and then proceed to finish it by a perpendicular wall above —In carrying out any great breakwater of the kind referred to, I do not look at any of those unusual or extraordinary means as promoting economy or saving time. I believe the only way in which you can construct breakwaters of the magnitude we are speaking of, is to go about it with all the appliances which modern science and experience would give, not resorting to either caissons or old ships. I do not believe that it is likely to lead to an economical or a profitable result. I believe the only plan would be to adopt the readiest and the most obvious mode; and in fact those plans which the experience of modern days and modern science point out. I do not think that the plan of sinking caissons or old ships is the best.

Do you consider, that in constructing a breakwater by means of old ships, danger would arise owing to the formation of the bottom, when the old ships were destroyed?—I think that that is one objection among many others.

When the caisson or the old ships were destroyed, would the formation of the breakwater inside be safe?—I think not; but I would go further and say, we are now contemplating breakwaters in seven fathoms of water, I think the chances are, that the vessels would burst, and the materials would be dispersed to some degree, particularly if they had a superincumbent weight. But whether they would or not, I cannot imagine that sinking old ships loaded with stone is an economical way of constructing a breakwater.

Looking to the construction of the breakwater inside the ship, after the ship was destroyed, would the breakwater be safe?—The only reason for sinking old ships would be, that it would be an economical way of constructing a rubble breakwater; therefore, if it were decided on, I take for granted the bursting of those vessels would only allow the subsidence of the materials to an extent that would not materially interfere with the permanence of the work; but I cannot imagine a breakwater built in seven fathoms water by any of those expedients.

A ship would not be an economical sort of caisson?—It is a species of caisson, and if the caisson should be decided on as practicable, I think a cheaper, and better, and more efficient kind would be found in one built for the express purpose.

(*Chairman.*) In your works at Mill Bay have you sustained any inconvenience from the action of the worm?—Not the slightest. There are worms and shell-fish that act chemically upon the limestone; but I should as soon object to a coast of limestone rock as an inefficient barrier against the sea as a breakwater built of limestone, the mass is so great.

Have you not sustained any injury?—Not the slightest. In Plymouth Breakwater you may find stones that are holed.

Is not the mischief done very general in the Plymouth Breakwater?—You may see a great deal in walking along the slopes of the Plymouth Breakwater, but I apprehend that it is not a practical objection.

You do not think it is an objection against the use of limestone?—No; I should not, as a practical man, object to it, where the mass is so great.

What is the estimate per yard of the present breakwater in Mill Bay?—We do it very cheaply indeed; we have the materials close at hand, and run them out on temporary stages, and the material is dropped through the bottom of the waggon directly into the work. It is costing us an extraordinary small sum. The whole pier, which is about 500 feet long, will not cost more than 33,000*l*. I should say per cubic yard, the materials, including what the stone would sell for, certainly not exceeding 2*s*. 3*d*. a-yard in the work; I mean that if you measured the cubic contents of the work, the materials in the work would not cost more than 2*s*. 3*d*. a-yard cube. Of course that has nothing to do with the facing of the pier.

Take a yard of breakwater from the bottom up to the top?—That I cannot tell, without going into a calculation.

Will you have the goodness to look at the plan before you of Dover Bay; are you of opinion that the sketches now before you present a good plan for a breakwater, with any modification you may recommend in them?—I have very great hesitation in approving or disapproving of either of those sketches without having made personal examination. I have no doubt those who made the plans have taken the precaution of doing so, and that they are competent to the task. I am perfectly satisfied of this, that a large area should in all cases be preferred; and the larger such area the more likely you are to have a successful result.

That is, you would have less liability to silt up?—Suppose the opening to be the same, manifestly so. I think in all these cases we have committed a great error, from being afraid of making our works too large.

Would you recommend a close harbour, or merely a breakwater?—That again would depend upon the size that I was permitted to make it. If compelled to make a very small harbour, by which I mean anything under 150 acres, I should be disposed to make it as open as possible. If I were permitted to make it 300 or 400 acres, it would be different.

Take 600 acres?—I should make it as close as possible.

J. M. Rendel, Esq.
19th June, 1844.

Should you apprehend any great silting up in a harbour of that magnitude?—Not with a reasonably large entrance. Of course the entrance to a large harbour need not be larger than the entrance to a small one; and I believe that the silting up of a harbour of this kind, where there is no back-water to affect it, will be in a very considerable degree greater where you have a large opening, compared with the size of the harbour, than the contrary. I think the silting up will be much determined by the size of the opening, all other circumstances being the same.

Are you for or against a large opening?—I am for a large opening, as regards the use of the harbour, but for a small one as regards the silting up; and therefore, inasmuch as the opening should be the same, whatever is the size of the harbour, I think a large harbour should be preferred to a small one.

What do you think a sufficient opening for ships coming in?—I do not think the opening for such a harbour as this in the largest plan before me ought to be less than 500 feet.

Would you have an entrance at each end in such a harbour?—That would certainly add to the convenience of the harbour for shipping; but I doubt very much whether it would not injure the harbour in an engineering view; if you had two entrances you would be much more likely to silt up with a close harbour: if you had a detached breakwater, and your object was a shelter from prevailing winds, I should put the breakwater in the line of the currents as nearly as possible, and leave the harbour as exposed to those currents as I could, consistently with sheltering the roadstead. But if you have a close harbour, I should say, for all engineering purposes, that one entrance was better than two; for the convenience of shipping two entrances may be better than one in many situations.

If either of these places were adopted, showing a line coming out from Cheesman's Head, should you have an apprehension of the shingle getting into the harbour?—Not if it came out into the depth here stated.

If it came out into the depth of seven fathom, should you have any apprehension?—Not the slightest in the world; I do not believe that the shingle travels at anything like that depth.

On the score of economy, should you prefer one or two entrances to a harbour of that sort?—On the score of economy, I should prefer one; the forming the head of a breakwater of that kind is a considerable work. The two heads would be about five times the cost of the length of the opening; it is a very formidable thing to make a head to piers of this kind.

If you constructed a breakwater at Dover, if I understand you rightly you would do it by the deposit of stone, you would not do it by caissons?—There must be something more in favour of caissons than I am aware of—something in the locality much better adopted to their use than I know of to induce me to use them as the preferable mode.

What should you think desirable in the locality to induce you to use caissons?—I should certainly require some very extraordinary conveniences for the appliance of caissons, and I do not think that they exist at Dover; suppose I could find in the immediate neighbourhood a sheltered place where I could build my caissons, and where I had stone that I could put into them, and where I had every convenience that would make them applicable both on account of economy as well as local circumstances, I should use them; but I do not know of anything of the kind existing in the neighbourhood of Dover. As to the use of chalk in the caisson, I do not think that an engineer would take upon himself the responsibility of sinking caissons filled with chalk in seven fathoms water.

What would be the objection to chalk?—In the first place it would be liable to burst the caisson, the chalk would be dispersed, and you would be ruining the harbour instead of improving it; and if it is merely to form a nucleus, I think it is a very expensive way of obtaining that end; and I think that the difficulties are increased immensely by the proposition to build in seven fathoms water. I must repeat that you incur a great deal of risk in attempting a caisson in more than three fathoms water. All the timbers would have to be scarified for I cannot imagine any caisson to be profitable that would not bring you above low-water; and if you are to be brought above low-water in anything more than three fathoms water, it is a very formidable machine.

The made caisson would be far more useless than an old ship?—I think a caisson would very soon become in effect an old ship if sunk: I doubt very much if a caisson sunk in six or seven fathoms water would not very soon become a wreck, which I take for granted an old ship is before you sink her.

How would you recommend a breakwater to be formed in seven fathoms water?—I should be more disposed, if I had to build one in seven fathoms water, to adopt the plan I before referred to: suppose I had an unlimited command of materials, I should first of all begin to deposit those materials to form a rough mass up to within a moderate depth at low-water, and then when I had brought my foundations up to that point at which the sea would begin to attack me, I should begin to attack the sea by building with a class of materials that would be its master.

In the shape of an upright wall?—I think an upright wall in that case might be desirable.

A class of materials meaning what?—Certainly stone or vitrified brick, for the face work, built in large masses with cement, and carried out and put in position; and I am inclined to believe that brick-work of this kind might be adopted with great advantage in situations where stone would be too expensive. The interior of the blocks might be formed of the common brick of the locality, and the work could be built either by the diving-bell or by the ordinary setting machinery.

(*Lt.-Col. Colquhoun.*) You stated, in reference to the breakwater at Dover, that you

J. M. Rendel, Esq.

19th June, 1844.

have no fear of shingle in seven fathom water, are you aware of such a formation going on in deep water for many years past at Dungeness Point?—I am not aware that in that case you get any shingle to a greater depth than perhaps very little below low-water.

For the last 50 years the point has been protruded outwards five feet 20-hundreths every year?—I think it is an excellent opportunity which you have now of ascertaining all those facts; I do not know a case where the shingle exists in any mass below the level of low-water, or where it has travelled round a point projecting into two fathoms at low-water.

Is not it travelling round Dungeness Point?—I should like that to be thoroughly ascertained; my attention was first called to the travelling of shingle in a case on the coast of Cornwall; I was called upon to design a harbour in Mounts Bay, between two headlands, or rather two points of rock, which protruded out into about two fathoms of water at low-water. On either side of these points are other bays. The shingle of this central bay is entirely composed of the debris of quartz rock. It is nothing more nor less than small pieces of quartz that in the process of time have become rounded by rolling to and fro (as the southerly or westerly or easterly winds prevail) over those two or three miles of shore. When westerly winds prevail, this shingle accumulates at the eastern headland;, when the easterly winds prevail it travels back again and accumulates at the western headland. On the other side of those headlands you have quite a different kind of shingle. If the shingle travelled round either of those headlands, it would be detected from its being of a totally different kind to that which forms the shore east and west.

What is the depth of water at the point?—I do not think it is quite two fathoms of water. You have the same kind of shingle point as at Dungeness; at the Kicker in Stokes Bay, near Portsmouth Harbour, which is growing up in the same way.

Do you conceive that the accumulation of shingle is due to the wearing away of the cliffs, or is it thrown up from the bottom of the sea?—My conviction is that it is due entirely to the falling of the cliffs from time to time, I cannot imagine the sea acting upon its bed in deep water in a way to break up the solid chalk. Wherever my attention has been called to the coast, I never found the shingle much below low-water. I have never known it in one instance below low-water mark.

(*Mr. Walker.*) Do you or not know that since I have had the direction of Plymouth Breakwater I have made it a point, both in my Report to the Admiralty and also my orders at the breakwater, that the interstices of the large stones should be filled up with small materials?—I was not aware of that fact, nor was I aware that you had the entire management of the work.

(*Mr. Walker, for Sir Howard Douglas.*) Do you consider that the force with which the seas act upon a surface opposed to them is greater upon an upright or a sloping surface?—As the question has reference to a breakwater, I think if its perpendicular face springs from a point at which a wave would be when lowest, and rises above that at which it would be when highest, the action of a wave is less against a perpendicular face than upon a sloping one. In all cases of sloping breakwaters that I have observed, it is not the upward action of the wave only that does damage to the slope; the recoil of the wave is almost as injurious. But it should be remembered that we have recourse to sloping breakwaters in order to make cheap materials stand in the place of expensive labour. In order perhaps to draw a fair comparison of the effect of a sea on a sloping and perpendicular wall, one would like to see the same degree of care used in making the slope as is common in building a wall.

My question was rather a theoretical one?—In theory I think it will be less upon an upright wall, under the circumstances which I have assumed, that is having reference to the time during which it acts, and the surface upon which it acts.

With respect to Dover do you think that there will be any great fear of that extent of harbour silting up, namely, the extent enclosed within the largest projected lines of breakwater, forming an area of 500 acres?—Not with an opening of 500 feet only. At least I should be quite content to consider it as a permanent harbour.

Do you know any instance of any harbour silting up by the action of the sea-water?—Not as a parallel case to this. We have some instances of harbours upon our coasts that have accumulated sand and silt to a degree which may be called destroying them.

To what harbours do you allude?—Rye, Hastings, and other harbours of the same class, along the eastern coast.

They are tidal harbours?—Yes.

Do not you think that in most of the harbours we hear of as having silted up, it is chiefly due to the streams which come from the country, and are allowed to run into them?—No, I do not; I do not think so much injury is done by the rivers emptying into our large estuaries as many engineers do, because in many of our large estuaries, where great and rapid changes are taking place, the rivers running into them are too insignificant to effect those changes. It would be absurd to attribute them to any matter brought down by such rivers. In all small harbours, it is a great object to keep away indraught. I believe if you have a harbour with a long estuary attached to it, up which the tide flows, and you have a very great indraught, the chances are, if the harbour has a large mouth, and a place where the matter carried in by the indraught can accumulate without being acted upon again by the return stream, the indraught in such a case is a positive injury. I would wish to draw this distinction, where you have a harbour with a very large mouth, and a strong indraught on a sandy coast, bank will be formed in places out of the reach of the ebb-waters, and of course the bank become permanent accumulations. I should say the most perfect harbour of that sort you could have upon a coast encumbered with sand or shingle, would be by letting the tide enter through one mouth and ebb by another. That is, to let the stream fill the estuary by a separate mouth,

J. M. Rendel, Esq.
19th June, 1844.

and come out by the harbour's mouth. An arrangement of that kind is much more likely to prevent silting in a harbour than where the stream runs in and out by the same entrance.

Supposing the projected breakwater to be carried out in Dover Bay, would it not be desirable to turn the small stream which now runs into the harbour to the east or the west?—I think it would. I cannot see any objection to it. No good could possibly arise from the stream, and it might do harm.

If a breakwater were constructed nearly parallel with the coast, which I apprehend is in the stream of flood-tide, do you consider, the breakwater being two miles long, that any ill consesequences will arise from silt or deposit within the line of such breakwater?—I think not, if the line of breakwater does not interfere with the line of the currents; that is, having ascertained what is the prevailing line or direction of the tidal currents, the breakwater should be made parallel with that line, then I do not believe there would be any silting up at all.

It is generally stated, and has been proved, that Dungeness is growing from an accumulation of shingle in the direction of the point; the shingle working both ways, that point is said to be extending, should you apprehend any obstruction to a harbour of refuge within such a breakwater as this, which has been described to you from the shingle accumulating on that point?—I think the building of a breakwater would be one means which an engineer would adopt for preventing the further accumulation of shingle at that point. The placing a breakwater judiciously in that position must increase the shore-currents. I take it for granted that the growing up of that point is due entirely to that being the meeting place of two currents, which are so nicely balanced that neither prevails. Give a preponderance to either, and the effect will be very different. I think that an admirable position for a breakwater.

On what ground do you think it an admirable position for a breakwater?—I think you would have less liability to injurious change arising from the construction of a breakwater there than in any other place to which my attention has been called; and if any change takes place, the effect will be to prevent the further accumulation of Dungeness Point and that would be desirable rather than the contrary.

Is it not a highly desirable thing to encourage the lengthening out of that point on account of its giving such an admirable protection to the bay?—I am afraid we do not look to the ultimate consequence; let that process go on to a great extent, and instead of the point becoming the means of sheltering the bay, the bay will become shoal. Suppose this point to grow up faster than the shore of the bay, the strong current along the shore, to which you owe the deep water would be lost, and give place to quiet water, or a repose in which the shingle would accumulate. The point would then again grow up, and the shore would again accumulate as before. Of course as the accumulation advanced into deep water, they would be less apparent, and might be altogether stopped after reaching a certain degree of exposure, but the shore would participate in every advance of that point.

Is there not at all times risk in interfering with the natural operations of that point, that what you propose as a breakwater may have the effect of doing mischief, which you do not contemplate?—Of course there is always risk, if you at all interfere with natural operations. You may change them for the worse instead of for the better; but I have always found that in building breakwaters, or other works in the sea, the surest plan not to produce those prejudicial consequences is to go with nature, and to build in the line of the currents; if you do so, the chances are that you will make those currents work with you, instead of against you. For instance, here I have referred to this fact, that the point must grow out from the circumstance that you get a balance of forces on each side of it, and the consequence is that a kind of eddy is formed which produces that point; if you build a breakwater along here, the consequence will be, that you get a stronger in-shore current than at present, and that will necessarily make the forces on this side more active than the forces on that, and instead of the point growing in this direction, it will go in that direction.

Have you ever been at Dungeness?—I have been there, but not professionally.

Are you aware of a shoal extending from the front of where the breakwater is proposed to a considerable extent, and then falling suddenly into deep water?—I am aware that there is shallow water here, but then there is deeper water outside, and that is a corroboration of what I have said about the formation of the point; if that point grows, the shoal will come further out, you do not make a larger bay, from the growing out of that point. The bay sympathizes with the growth of the point, and if the point accumulates, the bay will accumulate. You will only maintain a deep bay, by inviting a stronger current along the shore, which a breakwater judiciously designed would secure.

As this point extends out, you admit that it forms a better shelter and protection to the bay?—If you could induce nature to form a point here, to the extent which would afford the protection you desire, without carrying on the same process in the bay at the same time, then the growing up of that point would increase the shelter in the bay; but if the filling up of the bay is to keep pace with the growing up of the point, no advantage results, and that I anticipate; my conviction is, that you cannot induce the growth of this point by the operation of the natural currents, without the shore sympathizing with it. Old charts have been referred to—a chart made 100 years ago; any one who would draw a conclusion from it must have more confidence in charts of that date than I have; I am satisfied they are not at all to be trusted. I do not know an instance where a point has grown up from a balance of currents as this point has, where the shelter of the point itself has not brought snallow water along the shore.

Are you aware of the state of this beach, and the difficulty of landing?—Yes.

If a breakwater were built here, would it not be necessary to build a harbour also?—I think you must, to make a perfect harbour, here, have an inner harbour, where pilot-boats

J. M. Rendel, Esq.
19th June, 1844.

and stores might always be kept, and assistance readily rendered to vessels. That is rather a favourable position for such a small harbour, but I should like to be quite understood about the growing up of this point, for these are subjects to which I have paid a great deal of attention; supposing a breakwater to be built along here in the direction of the current, every one will admit that the current would be strengthened on the inside or shore side of the breakwater, and the effect would be, not only to prevent a further accumulation of shingle within the breakwater, but to remove a portion of that which is now there, and increase the depth of water.

You do not anticipate that Dover Harbour, on the plan that has been adverted to, would be in danger of silting up?—If you make Dover Harbour of the proposed capacity, viz., 500 acres, with an entrance of not more than 500 feet, I do not believe that it would silt a foot in depth for 30 or 40 years. We should always remember that the filling up of a harbour of this kind is due to the size of the opening, all other things being the same. The sea which carries matter in suspension rolls by the entrance, and if there is any matter in the waves, a portion of it goes in. It is manifest, therefore, that the quantity of deposits must depend upon the quantity of matter so transported by the sea; and the quantity which gets into the entrance must be manifestly due to the size of the entrance; and I have observed, invariably, that in all situations where you have large and small basins under precisely the same circumstances, if the entrance of the large basin is of the same size as the entrance to the small one, the accumulation in the large one is not at all in proportion to that which takes place in the smaller one.

The subject of a breakwater to enclose Portland Roads, having been under the consideration of the Commissioners, you are requested to examine the sketch before you, and state your opinion as to the direction, materials, and form which you would recommend to be adopted for that breakwater?—I should say, in the first place, that before anything at all is decided upon as to sheltering Portland Roads by a breakwater, it is important to know the nature of the base of Chesil Bank. There again we see a bank formed by the effect of the tidal currents and waves. If this bank is entirely a mass of shingle, then by sheltering it on one side, and leaving it exposed on the other, I am not sure that it would retain its position. I think, therefore, it is very desirable before you even discuss the subject of this breakwater, to know exactly the nature of the ground upon which the bank is formed; if it is a mass of shingle to below low water, and you were to make this side so sheltered as it would be by the proposed breakwater, leaving that side unprotected, I am not satisfied that you would have a permanent harbour,* otherwise the large extent of deep and admirable anchorage which the proposed breakwater encloses makes it a very desirable work.

Suppose a breakwater were built there, would you have an opening which should be convenient for ships in particular winds, when they could not get round the north point?—You might find that a desirable convenience under the circumstances referred to; one does not, however, like more openings in a harbour than are necessary.

Where would you put the opening?—As much to leeward as I could with propriety; I mean nearest to the shore; I say to leeward, because the north-north-west winds are spoken of as the winds which would prevent the vessel getting out.

It has been suggested that vessels coming out with a scant wind would have a lee shore the whole way out, does that make a difference?—Much of the object would be lost by having it far to windward.

What do you think of one-third from the shore?—The utility of the opening would be impaired every foot that you went to windward, particularly as you have such a large portion of the bay already to leeward.

What do you think of a distance of one-third from the shore, whatever the breakwater is?—I think that would be the extreme limit of usefulness.

You recommend an upright breakwater?—Yes, where the water is so deep that you could bring up bold and abrupt slopes to within a few feet of low-water spring-tides, and upon them rear the perpendicular walls.

You would recommend an upright superstructure, standing on a foundation of a slope up to near low-water mark?—Yes.

Would you recommend the slope to fall into a vertical line by a curve, or would you have an angle?—When I had brought up the work to within a few feet of low-water, I should round off the top, and make it as solid as I could, by packing of some sort, and then build upon that the perpendicular walls, but not till after it had acquired the requisite degree of solidity, which it would in two or three years.

Assuming that interval of time, would you recommend that such a work should be executed by building it from the bottom with large masses of solid stones, or by means of caissons filled in with concrete, or with any other substance and sunk?—I should certainly hesitate to a very great degree before I attempted to form even a nucleus for a breakwater in 7 fathoms of water by means of caissons; I know that caissons of infinitely smaller dimensions than those which would be required for a work to be founded in 7 fathoms water are difficult to be managed in a rapid tideway, and under the ordinary risks of building in water, and I certainly feel that the readiest, safest, and in the end, the least expensive way, would be to drop the materials in their place in the ordinary way; I should prefer dropping the materials perpendicularly to throwing them in over an end embankment.

And you think that a work so constructed would be the most solid, and, ranging over a long period of time, would be the least expensive?—Yes.

Do not you think that, in that depth of water, it would be more expensive than a common rubble wall?—Yes.

* Since Mr. Rendel's examination, Sir Byam Martin has ascertained from C. A. Maning, Esq., of Portland Castle, a gentleman of great local information, that the base of Chesil Beach is clay.

J. M. Rendel, Esq.
19th June, 1844.

Could you make stone, thrown down, stand at the abrupt angle indicated in th section of Colonel Jones?—In Mill Bay Pier, at Plymouth, I took a great deal of precautio to form the slopes; I had a line of rails laid on a stage, with the intention of using a diving bell for preparing the slope sufficiently deep for a steamer to come alongside. To my grea astonishment, on taking the sections, even in the deep part, I found that the materials had stood at a slope of four inches to a foot.

Would you recommend the interior face of the profile to have a little slope?—I should say that, in the superstructure, a batter of two inches to a foot would be desirable for the upright wall.

What was the size of the stone which you spoke of as standing four inches to a foot? —About one-third of the whole mass was from 6 tons to 2 tons, one-third from 2 tons to 2 cwt., and the rest what is ordinarily called rubble.

With reference to the Portland Roads, are you of opinion that the construction of a second entrance would be injurious to the breakwater itself, or would it materially add to the expense of the work?—It would add to the expense of the work, because an entrance without perpendicular heads would really be a great nuisance to the harbour, and, if brought up with perpendicular faces, they would be expensive; it would, therefore, be more expensive decidedly, but I should say not materially so; having reference to the whole of the circumstances, I do not think it would add materially to the expense, nor do I think it would be injurious to the work.

Do you know Newhaven Harbour?—I am professionally acquainted with Newhaven Harbour.

Supposing it to be desirable to improve Newhaven Harbour, are you prepared to give the Commission any opinion as to the best mode of carrying it into execution in order to increase its capability for receiving armed steamers, and for the more easy access of merchant-vessels seeking shelter there?—This is a case where I think the harbour would be better maintained by having no indraught at all. I doubt very much if you were to extend the present piers out, even into two fathoms water spring-tides, and allow the indraught which now exists, whether the channel would not fill in to its present depth of two feet at low-water; I doubt whether you could keep it deeper. The indraught is quite sufficient to take in more sand than the back-water would bring back. If this wall could be lengthened and the harbour enclosed by another wall in this direction, leaving the present harbour's mouth as the filling mouth, and diverting the water of the ebb-tide through that new mouth, we should then maintain deep water along this wall, in all probability, quite out to the entrance.

Do you mean that you would have two channels?—I mean this: assuming that the harbour is filled by the present entrance, then it should be emptied by the new entrance; then you would get rid of all the indraughts through the new harbour, and have nothing but the outward current. If you have an indraught through the piers the sand would get in and fill up in this corner; but if you could have the harbour filled by the western mouth, and emptied by the eastern mouth, it would be otherwise.

How would you effect that?—You might effect it in many ways. It might be done by gates across here, by self-acting gates, opening with the flood-tide and closing with the ebb. Some such plan as that would be the only one which you could look to for giving a permanent harbour according to this plan.

(*Capt. Washington.*) What should you think of extending the western pier of Newhaven into 12 feet water, and then removing this eastern pier, and having one in the direction of Catts Mill?—I doubt very much if the result would not be a perfect failure; the whole and sole existence of the harbour at present depends upon confining the water in that narrow channel; if the water were not so confined the inward draught would fill the channel to its present depth.

Do you think favourably of a breakwater in Seaford Roads?—I do uot know enough of the soundings there to answer the question. I should have no fear, from what I know of the Bay, that a breakwater, judiciously placed, would predispose the accumulation of shingle. I know that the currents through here are strong and parallel with the shore. In all these cases the great apprehension is of foul currents. Referring again to Newhaven, I am afraid that by merely extending the piers out into deep water you would not be able to maintain that deep water at the point where you would terminate them. I think the inward draught would be sufficient to take the sand into deep water between those piers, whilst the outward draught would not be sufficient to remove it.

(*Chairman.*) Suppose ultimately there should be a breakwater here, and it was desirable to have a basin here, do not you think that Catts Marsh would be a good position for it?—I think it is an excellent one, if you could bring that pier from Seaford Head, restore the back-water, fill the estuary through this mouth, and empty it by that opening into the new harbour, that would be a good plan.

Do you mean to empty it by means of gates?—No, I do not mean to empty it by means of gates; all I want to see is the removal of all indraught from the new harbour, which does more harm than the river and tide upon its ebb can do good.

In the event of its being determined to form a harbour at Newhaven, for the coaling and refitting of steamers simply, do you anticipate any difficulty in forming such a harbour?—I think you might, with some degree of certainty, at a moderate expense, make a harbour which would give you from six to eight feet of water at low-water spring-tides. I do no think, without a very great expense, and altering the whole circumstances of the harbour as at present existing, that you could maintain a greater depth of water than that.

Not 12 feet at low water?—I do not think you could.

Do you think that there is much deposit in Newhaven Harbour from the stream

J. M. Rendel, Esq.

19th June, 1844.

that flows into it?—No; and what deposit there is from the upper country is almost all soluble matter. Except as the medium of forming a kind of mud concrete, which is very formidable to remove by scouring, I do not think that there is any harm to be anticipated from the river deposits.

In the event of the channel being dredged to a general depth of 12 feet at low-water springs, do you not think that an outset running at the rate of five knots an hour, which it does, would maintain it clear?—If, after you had got the channel dredged 12 feet deep, you could maintain the outset at the same rate as it now runs in the present channel, which is two feet deep, I think it would; but there is the difficulty, as you increase the sectional area of the channel, the quantity of water being the same, you of course decrease its velocity. The very fact of your increasing the depth is tantamount to reducing the velocity.

Admitting that it was reduced to the rate of three miles an hour, would not that be sufficient to keep it clear?—I think a velocity of three miles an hour would drive out all the matter which the river brought down, and all the light matter brought in by the sea-water. I do not think there is any such matter which would not be held in suspension in a current of three miles an hour.

If you dredged to a certain depth, you think that, being a stiff clay, it would maintain that channel?—I think so.

You are aware that the present velocity of five knots an hour causes great difficulty to vessels entering the harbour; would it not be a benefit to the navigation if that rate were reduced to three knots?—No doubt about it; it is one of the difficulties. The fall which takes place immediately within the pier-heads: I have known a vessel thrown full on to the pier-heads, and there is great difficulty in keeping them off.

What steps would you take for bringing the harbour to the state that you describe?—I would increase the quantity of back-water as much as I could by restoring those marshes from which the tide has been excluded: and I would prolong the present piers into 8 or 10 feet water, and dredge the channel down to that depth into the strong clay, and then I think you might be able to maintain a depth at the entrance of from six to eight feet; but I doubt whether you could hope to maintain a greater depth by the mere scouring power which you have at Newhaven.

With that sort of bottom it would not do probably, though it might in sand, to use a kind of dredging vessel, which disturbs the mud without filling barges with it?—After you had built your piers, I think you might harrow out the mud without bringing it up in the bucket. Let what would be buckets in the ordinary dredging-vessels be harrows, so as to cut up the mud, and then I think you might very well afford to scour upon the ebb, and let the tide carry the soil out to sea. I do not think that there would be any fear at all, if you did it at that time of tide when the current is strongest, but that it would be carried to sea.

What width of piers would you recommend, all circumstances being taken into consideration?—If the harbour is to be principally for the accommodation of steamers, I would have the width between the piers a minimum size.

That being how much?—I should not make it much more than what the piers are at present.

Have you any knowledge of Harwich Harbour?—I have.

Are you aware of the lengthening out of the Languard Point and the wearing away of the Beacon Cliff?—I know that one of those points is growing up because the other is being worn away.

Are you aware of the cement-stone being taken away from Felixstow?—I recollect hearing, when I was at Harwich, that people had been fishing up cement-stone there, and that they had prevented its acting any longer as groynes. I very much doubt whether that is the cause of all the accumulation here.

Suppose it to be so, do you believe that groynes along here would supply the deficiency?—No; I think not. Taking the thing as it is, we have these facts, that the west shore has been washing away, and that the east shore has been growing up, which, if I read nature aright, implies that the quantity of water which the estuary contains is only capable of keeping open a certain width of mouth, and that if the mouth on the one side is enlarged, it would be contracted on the other. I think, therefore, that by this plan of carrying out a pier from Beacon Cliff to Cliff-foot Rocks, you would so far contract the entrance to the harbour, as to enable the water to maintain a good and sufficient channel, say, of a minimum depth of 14 or 15 feet, after having once removed the Altar and other shoals, which interfere with this depth, and that might be easily done, as those banks are more or less formed of cement-stone; a small bounty given to the men who get the stone would induce them to take it from there instead of the other place.

That is all that you would recommend with the clearing of the channels?—And a protection wall under the cliff in Mill Bay.

The groynes which they are going to place there would be unnecessary in that case?—Yes.

In recommending a protection wall to be erected to the westward of Beacon Cliff, do you recommend that for the purpose of protecting the land behind, or for the protection and improvement of the harbour?—I think, by building the pier, you would increase the action of the sea upon the shore in Mill Bay, and it would be nothing but fair to the proprietors, and indeed needful for the security of the pier itself, as the sea might otherwise get behind it. Undoubtedly, by building this pier the sea would strike and gather upon it, and act upon the shore with greater violence, and therefore you would put the landowners in a worse position than they are in at present, which I think you ought not to do.

Would the protection-wall, built in the direction you have shown upon the plan, fol-

lowing up the principle which you have just described, induce a greater action of the sea upon the land to the westward, and would that again oblige the wall to be carried farther, and so on, indefinitely?—You would gradually reduce the sea by breaking it upon the shore, instead of discharging it upon a point, which if damaged would defeat your own purposes. If you discharged the sea directly into this bight, you would soon have the Beacon Cliff separated from the main, for the sea would very soon get behind it. These are all very friable cliffs, and immediately the sea takes away the beach from the foot of the cliffs, down comes the face of the cliff, and you would have sooner or later to build that protection-wall, or you would have the sea behind the Beacon Cliff.

J. M. Rendel, Esq.
19th June, 1844.

Do you approve of the proposed harbour in Brixham Roads, and do you think that you would obtain the requisite shelter from that?—I think it is most important to have a breakwater in Brixham Roads, but to have a large and effective work there is far beyond the means of the local parties.

Is it not a great pity that the want of funds should prevent the breakwater being extended from Shoalstone Point, and thus a sheltered roadstead afforded for all ships likely to resort there?—If they could have obtained public funds I should have proposed the breakwater from that point, but that is beyond the local means.

From Shoalstone Point to what distance would you go?—I should have gone off about 1000 yards from Shoalstone Point.

[*The Witness withdrew.*]

Adjourned till to-morrow at 12 o'clock.

Thursday, 20th June, 1844.

Admiral Sir T. Byam Martin, in the Chair.

Mr. *William Stuart*, examined.

Mr. *William Stuart.*
20th June, 1844.

(*Chairman.*) In what capacity are you employed in Plymouth?—Superintendent of the Plymouth Breakwater.

How long have you been in that situation?—I have been employed at the breakwater from the commencement of the work in 1811; but as superintendent only since 1829.

In what situation were you before you went to the breakwater; what was your employment?—Carrying on public works as an engineer, under the late Mr. Rennie.

Has the breakwater sustained serious damage at different times in south-west gales, and if so, state on what occasions?—We have had several severe gales, and the work has been very much upset at different times.

What was the extent of the damage in the year 1817?—On the night of the 19th January, 1817, a severe storm occurred at Plymouth, during which the tide rose several feet above the ordinary flow of a spring-tide. The upper or finished part of the work was in consequence removed, and the stones thrown over on the north or inner slope. This was the first storm that materially affected the work.

What was the extent of the damage done?—I cannot say, exactly; but it was very considerable.

Was it not officially stated on that occasion, that what had happened might be regarded as a fortunate circumstance, as the sea had given the slope its proper shape, and that no apprehension need be entertained of any injury to it again?—That was the report of Mr. Whidbey to the Navy Board.

Did not the gale of wind in 1824 do infinitely more mischief than in 1817?—A great deal more.

Will you describe the extent of the mischief done on that occasion?—On the night of the 22nd, and morning of the 23rd of November, 1824, a most tremendous storm was experienced at Plymouth far exceeding in violence, and in its destructive effects upon the breakwater, any that had before occurred since the commencement of the work. The wind was from S.S.E. to S.W., and the tide rose seven feet higher than the usual rise of spring-tides, and three feet higher than ever before witnessed at that port. At this time 1241 yards in length of the work were finished in a rough state, of which 796 yards were overturned during the storm, which was only of a few hours' duration, leaving only 445 yards remaining, not much damaged at the east end of the main arm. The slope, as left by the sea, from low water upwards, was about 5 feet horizontal to 1 foot perpendicular, and in some places rather more. Messrs. Chapman, Jessop, and Rennie (the late Mr. John Rennie), engineers, were called in to report; and it was thereupon determined, in April, 1825, that a breakwater should be formed regularly from the level of low-water spring-tides, with a casing of rough squared blocks of granite and limestone, commencing on the exterior, or south slope, with a slope of 5 to 1, as the sea had left it; and on the inner, or north side, with a slope of 2 to 1. It was also determined to change the centre line of the breakwater, by placing it 39 feet 6 inches to the northward; thus leaving the great body of the stones to seaward, and increasing the slope, it being much easier to extend to the northward than the southward. It was also determined that the width on the top should be increased from 30 to 45 feet.

What was the object of increasing the breadth at the top?—To add to the stability of the breakwater.

Did you bond it together?—Yes; by masonry on the south slope and top.

In the shape of parapet or facing?—Not parapet, but facing or casing out; the whole top was paved. From this period the work proceeded as before described, until 1830, when it was found necessary still to add to the seaward slope, by depositing above 600,000

Mr. *William Stuart.*

20th June, 1844.

tons of stone, as a foreshore, 50 feet in width from the toe of the slope, at low water, at the west end, and 30 feet at the east end of the main-arm.

Was there any alteration of the slope when that addition was made?—There was no alteration in the slope; the 5 to 1 remained; but in 1833 it was determined to complete the extreme western end of the breakwater with a circular head of solid masonry, with an inverted arch, as the foundation of the lighthouse. The work continued accordingly until 1836, when it was considered advisable by me to make a proposal to the Board of Admiralty, which was submitted to, and approved by Mr. Walker, for continuing the south radius of the circular head to the north side, in order to extend its base. To extend the base was easy in execution, and as cheap as if it had been done according to the original plan. During a storm in February, 1838, a great quantity of stone was removed from the foreshore at the west end, and thrown over to the north side, and a portion of the masonry, where unconnected, or in an unfinished state, was likewise disturbed. In consequence of these circumstances an extension of the foreshore, at this part, was agreed upon. Another severe storm, in November of the same year, producing similar, though not equally extensive results, gave rise to the construction of a buttress. The object of this buttress was not only to secure the foot of the south slope, but also to afford protection to the proposed lighthouse, and to prevent the stones composing the foreshore from being rolled over to the north side. The buttress, as well as the work round the west end, at the foot of the slope, at low-water, are composed of granite masonry, dove-tailed horizontally, and vertically fixed with iron Lewis-cramps, the rough blocks formerly deposited being first removed, by the aid of a diving-bell, to the depth of from 3 to 5 feet below low-water, and the masonry then laid at the above-mentioned level. So great is the force of the sea at this part of the work, that stones of 10, and even, 15 tons weight have been taken from below low-water, and carried over the top.

From how far below low-water mark?—I believe from 4 to 8 feet.

What number of yards distance do you suppose the stone was carried altogether?—From 50 to 60 yards.

Will you state the size and cost of the stones that were used?—According to the first contract, made in 1812, for quarrying and carrying to the wharf, the sizes and cost were as follows: namely, stones of half a ton, and not exceeding two tons in weight, 1*s.* per ton; exceeding two tons, and not exceeding three tons in weight, 1*s.* 2½*d.* per ton; exceeding three tons, and not exceeding five tons in weight, 1*s.* 5*d.* per ton; and exceeding five tons, and not exceeding ten tons, 1*s.* 8*d.* per ton.

What is there in addition for depositing it?—2*s.* 10*d.* per ton for removing from the wharf and depositing at the breakwater.

What was the total expense of a ton of limestone from the quarry until deposited in the blue water?—About 4*s.* 6*d.* per ton, by the terms of the first contracts.

For how much do you suppose the Government did it afterwards?—The first contractors could not get on, they were obliged to stop; we had then to enter into a fresh contract, like the first, except that the minimum size of the stones was reduced from half to a quarter of a ton, and to give for quarrying and carrying to the wharf about 3*s.* per ton; but not more for carrying out.

How much more in the total?—1*s.* 4*d.* per ton.

In the construction of the breakwater, were any precautions taken to throw down the small stones to fill up the interstices?—There were no precautions taken until 1816, for filling up the interstices, except by the use, to the fullest possible extent, of the sizes now given; but in 1816, the late Sir Joseph Yorke and Mr. John Rennie (I having always been an advocate for small stones) agreed that much smaller stones should be used for this purpose, and which was ever afterwards accordingly done.

Can you state what was the expense of making good the damage on the occasions you have mentioned?—In 1838 the damage was about 1300*l.*; but with respect to the others my predecessor, Mr. Whidbey, never wished to go into particulars, or kept any account.

Is it the case that you have constantly to make good in the summer the damage of the winter at the present time?—No.

Is there not generally 15,000*l.* voted for the breakwater in each year?—Yes.

Is that for repairs?—For proceeding with the work.

Is the work not yet complete?—No.

How many years has the work been in hand?—Thirty-two years; but the breakwater, although unfinished, has long been efficient for the protection of vessels.

Do you attribute the damages you have stated in the years alluded to to the form and shape of the breakwater, and to the want of filling up the interstices?—In the first gales I attributed the damages to the fact that we had not length enough of foreshore, or of extension to seaward.

Not slope enough?—Not slope enough.

Have you given much consideration to the slopes of breakwaters generally?—I could scarcely help doing it from the position I have held, and at one time Mr. Whidbey was desirous of having the upper part of the breakwater from nearly low water with a very small inclination.

Do you recollect what was the inclination?—It was so small as nearly to approach to a perpendicular.

Did Mr. Whidbey suggest this, considering that the slopes which had been previously adopted were injudicious?—Yes; and he stated to me, when I objected to his new proposal, that the pier at Statten Point had stood, with a small inclination, and he thought a breakwater would do the same.

Mr. *William Stuart.*

20th June, 1844.

What was the objection you had to the more upright slope?—I was convinced it could not stand; and my belief was afterwards confirmed by the actual failure of a solid part of the breakwater, which had been built on this plan, and also by the failure of a part of Statten Pier itself, which had never to encounter anything like so severe a test as the breakwater.

From your long experience of the breakwater, would you, if the work was to do over again, adopt the same slope?—I should.

Would it not be desirable to raise it higher, to prevent the sea rolling over?—I do not think it would; as the sea is completely broken and lost when it rolls over.

Does the water, when it comes over the breakwater in that way, disturb the Sound much?—Not the slightest.

Has the depth of water in Plymouth Sound diminished much since the breakwater was constructed?—It was ascertained in 1842, that the depth had not at all diminished.

You state that in the year 1824 about 800 yards of breakwater were overturned?—Yes.

Do you think if the breakwater had been constructed in any other form, for instance, if it had been either wholly upright from the bottom of the sea, or upright from about low-water mark, that such a breakwater would have had power to resist the force of the sea which overturned that large portion of it which you have mentioned?—I think not.

Do you think that oblique planes of breakwaters, built in the sea, are better calculated to resist the force of the sea in the direction of motion than any upright work?—I do decidedly.

But in cases where you would erect any superstructure on a breakwater for batteries, or any such purpose, would you erect that superstructure, continuing your slope, or in what other way?—By extending the exterior slope, and building on it afterwards, up to the crest.

Having said you prefer a sloping breakwater, as best able to resist the force of the sea, you further state, from your own experience, you think the long slope of 5 to 1 is that which is most likely to remain in a state of stability?—I do.

What is the total number of tons of stone deposited, up to this time, for the Plymouth Breakwater?—3,514,885 tons. The original estimate was only 2,000,000 tons.

Are you still quarrying?—Yes, and carrying out. The original estimate for the breakwater, taking in some other works in connexion with it, was 1,161,100*l.*, and the total actual outlay (of which about the sum of 100,000*l.* remains to be expended during the next five years, when the whole work will be completed) will be within 1,500,000*l.*

You are speaking of this exclusively of the works in Bovisand?—No; inclusively.

Have you bestowed much reflection on the numerous projects, of which we have heard a good deal lately, or any of those taught by your profession, for constructing breakwaters or piers in deep water by means of caissons, by means of large blocks or masses, either of stone or of concrete, placed in wooden caissons or in cast-iron caissons, and in great lengths, so as to float them out in the line of the breakwater, and to sink them there with any confidence that the masses of masonry so laid would remain undislocated, and as capable of resisting the force of the sea as if they had been built upwards from the bottom by the aid of a diving-bell, or the other resources you can apply?—I have given consideration to these numerous projects, and consider them likely to answer only in very quiet water, and not in such exposed situations as Plymouth Sound.

Besides the difficulty of sinking these vessels from the disturbance of the weather, do you think it would be possible to build partially great masses of masonry in long caissons, or of any considerable length, and to sink them upon that bottom without piling; do you think that a breakwater, so constructed, would be likely to endure as long as a breakwater built of solid masses of stone from the bottom upwards?—If I were going to construct a breakwater I should begin nearly in the same way as has been done before, but in a much less expensive manner.

How would you propose to do it in a less expensive way?—I would begin by throwing in stones and getting the whole up to low-water mark, letting them find their own base in the first instance, with rubble stone, large and small together, and then that would become a protection, and the sea would level down and you could add to it again.

Would you carry it up to low-water mark?—Yes.

You would still continue the slope of 5 to 1?—Yes.

Do you think, upon the whole, that constructing a breakwater, say in six or seven fathoms, in that manner it would be more solid, more enduring, and perhaps in the end more economical than by any other of these projects of caissons?—That is my impression, and proceeding with a diving-bell or with caissons, would be certainly more expensive. There have been projects for putting caissons down in the centre, and then afterwards laying stone and rubble, both inside and out. That I should object to entirely, because if you put a solid body in the middle and then rough stones again they would blow out.

Why do you object to that?—Because the solid body in the centre would resist the air and the sea, and blow up what is outside. We know that from experience.

How do you know that from experience?—By building up solid masonry at the end of every year at the west end; when a storm came, that solid masonry caused some of the stones to be thrown up. The action of the sea blew up a few of the stones.

Mr. *William Stuart.*

20th June, 1844.

That solid masonry is on the top of the rubble, whereas the proposition you are now alluding to has the solid masonry below and the rubble above?—So much the worse.

In your replies as to the price of stone in the first and second contract for the construction of the breakwater, did the 4*s.* 6*d.* and 5*s.* 10*d.* respectively, include all the expenses of bringing off the stones and depositing them?—No.

What additional expense was there?—The expense of superintendence.

What was the smallest description of stone originally used in the construction of the breakwater?—Half a ton in the first contract, and a quarter afterwards. Subsequently Sir Joseph Yorke and the late Mr. Rennie, on visiting the work, authorized, at my suggestion, the use of much smaller stones, and subsequently still, what we call quarry rubbish has been also used.

Since what date was that?—Since 1816 as respects the smaller stones, and since 1830 as respects quarry rubbish.

You wished in the first instance to have small stones?—Yes, always.

Is there anything more you wish to add?—I will deliver in this paper. (*The Witness delivered in the same.*)

You say you think there has been no deposit in the Sound. Have you ever sounded it?—Frequently.

How much stone has been taken up from the bottom of the Sound and placed at the top of the breakwater?—We removed one rock by means of the diving-bell, which I should say, from recollection, was from 500 to 600 tons.

What is the extent of the injury done to the breakwater by the worm and other animals that attack it?—A mere bagatelle, of no consequence whatever. The pholas, a small shell-fish, gets into the stone, but only between low-water of the spring-tide and low-water of the neap-tide, and does not cause it injury at all. I have never known the pholas bore in the stone more than 3 inches; it goes in like a pin point; and at that depth it is probably nearly about a quarter of an inch in diameter. When we were removing the stone in the interior with the diving-bell, we never found any of them; they are only at the outer extremity.

What price are you now paying for the freight of stone?—10*d.* by contract; but by Government, more.

Do you mean in Government vessels?—Yes.

What makes the difference?—The Government vessels carry out all the heavy stone.

Is it more economical to do it by contract?—Doing work by contract, which is merely for quarrying stone or for carrying out, I think is the cheapest mode; but in a public work like the Plymouth Breakwater, I would not employ contractors to do a particle of the work outside. I am convinced that since the management has been by Government officers we have done it a great deal cheaper.

Can you give any opinion as to the proportion between the cavities within the breakwater and the solid parts?—Supposing the weight of the stone to be 13 feet per ton, I think a ton of stone occupies from 15 to 16 or 17 feet of space of the breakwater, taking the mass.

(*Lieut.-Col. Colquhoun.*) What is the largest piece of stone you have ever deposited in the breakwater?—The largest limestone has been 20 tons weight. After the first gale of 1838 we put down stones of 15 and 20 tons weight, and some of those were rolled over.

Was that limestone?—Yes.

What was the weight of the granite?—None exceeding nine tons.

Did you in proportion find the granite roll over as much as the limestone?—The granite was all used as masonry, which was dove-tailed both horizontally and vertically and could not roll over; it could not get out.

Was any part of that granite ever rolled or washed out either vertically or horizontally?—Yes; there were a few stones towards the west, and that were only dove-tailed horizontally.

What weight were those stones?—Five tons.

Were they lifted up by the sea?—Yes. Those were not dove-tailed vertically.

How were they secured?—Laid joint to joint; and I conclude that the solid masonry checked the sea and caused the stones to be blown up; but only a few in 1838.

Is it your impression that the granite lie quieter than the limestone?—Not at all. The limestone is heavier in proportion than the granite.

What is the specific gravity of the Plymouth limestone?—13 feet per ton.

What is the weight of the granite you use; how many feet per ton?—14.

Where does the granite come from?—A great deal came in the first place from Dartmoor; but latterly from Fowey.

Have you ascertained the specific gravity of each?—I have.

Which is the heavier?—I think they are very nearly the same.

Was not the original plan which was recommended by Mr. Rennie and Mr. Whidbey, to have a part of the breakwater above low water nearly parallel, and was not their original estimate founded upon that?—I believe it was, though until lately I never saw any drawings of it.

Was any part of it ever made upright?—Never.

So that the upright building was never tried?—Never.

In what degree do your soundings in Plymouth Sound differ now from Mr. Smith's soundings in 1792, or is there any difference?—I think only a slight difference, just within the breakwater.

Mr. *William Stuart.*

20th June, 1844

To what extent from the breakwater has it shoaled?—Not half a cable's length.

To what degree has it shoaled in that part?—Probably a foot or 14 inches in some parts; and great part of that is filled up where the Shovel Rock was.

You are aware it has been said that the depth has taken the form of an equilateral triangle, the breakwater being the base, and has deposited several inches of silt?—Not so much as an equilateral triangle; round here it is as clear as ever it was. (*The Witness described on paper the smallness of the extent.*)

What is the greatest number of ships you have ever seen at anchor in Plymouth Sound since the breakwater has been constructed?—One hundred sail of different kinds.

What number do you suppose it capable of holding of the description of vessels you have seen there?—I think you might have double that number in it, or nearly so.

What is the area within it?—I do not exactly know, but Government takes a large part, where merchant-men cannot go.

Have you ever known any instance of embarrassment and distress to vessels running in, by getting embayed, and not being able to get into the Sound?—Never, if they took proper precautions.

What precautions?—Dropping anchor in proper time, by neglecting which a Dutch vessel coming in with an easterly wind at the east end of the breakwater, ran down towards Cawsand Bay.

When running into a deep bight of that kind, have ships become embarrassed, and got embayed between the Lizard and the Praule?—I have not known such an instance.

Did you ever know a ship running in with a gale of wind in the south-west, take up anchorage in the Sound part, and get aground?—I never did.

Did you ever know a ship part from her anchor since the breakwater has been made?—Frequently.

And run where?—Yes, into Cat Water.

Did you ever know a man-of-war part from her anchor?—Yes, in 1817.

What ship was that?—The "Jasper."

What became of her?—She became a wreck, and every soul perished except one man.

In Plymouth Sound?—Yes.

Had she not anchored down on the Scotch ground?—She was farther in than the Scotch ground.

Was the work of the breakwater so far advanced as to afford any protection to the Sound?—No.

Was she anchored in foul ground?—Yes.

Have you ever known for the last ten years a ship driven from her anchor?—No.

Have you ever known any difficulty in ships bringing up since the breakwater has been constructed?—Never since it has afforded sufficient means of shelter. In the gale of 1824, we had 18 wrecks at the time that the breakwater was turned over, within half a mile between Queen Anne's Battery and Monkey Dore, and owing to the sea breaking in after the breach was made in the breakwater. These vessels were all merchant-men.

[*The Witness withdrew.*]

James Meadows Rendel, Esq., re-examined.

J. M. Rendel, Esq.

Were you engaged professionally in the construction of a breakwater at Brixham?—The lords of the manor of Brixham engaged me to design a breakwater at Brixham, but their funds are so limited that they cannot afford to pay London engineers. It is now under the charge of Parliamentary Commissioners, being inhabitants of Brixham.

Was the breakwater you designed for them simply for the protection of the small harbour of Brixham?—It was, and for the shelter of vessels of 14 feet draught as were endangered by seeking refuge in the bay should the wind chop round to east.

What capacity has the anchorage within the breakwater?—There are 115 acres within the breakwater which I designed; the greatest depth of water at low-water is four fathom, shoaling up to one fathom, which is almost close to the shore. The question which I was desired particularly to be prepared to answer to-day was, what would be the cost of a breakwater 1000 yards in length running off into five and a half fathom water from Shoals Point? I have made out a rough calculation of that, and I find that about 300 acres might be enclosed for an expense of 250,000*l.*

How long?—One thousand yards.

To what depth of water would it carry you?—Five and a half fathom.

At low-water?—At low-water.

What points does it shelter?—There is hardly a point that it would not shelter. Out of the 300 acres there would be perfectly land-locked at least 150.

And capable of receiving the largest ships?—Yes, five and a half fathoms in quiet water. Of course there the cost would be comparatively small on account of the facility of getting materials.

What is the nature of the stone or rock there?—It is remarkably compact, and solid limestone rock.

Where would it come from?—The whole of Berry Head is a mass of limestone rock of a very compact kind.

[*The Witness withdrew.*]

Captain *Geo. Richardson.*

20th June, 1844.

Captain *George Richardson,* examined.

(*Chairman.*) What is your situation?—I command the "Herefordshire," in the East India service.

Have you been much accustomed to the navigation of the British Channel?—I have been 34 years at sea, continually going up and down Channel in the West India and East India service.

If you were called upon to state your opinion as to the best situation for a harbour, for the convenience of the trade in the Channel, and also for a squadron of steamers to watch the opposite coast and protect the commerce, what port would you select between the North Foreland and Portsmouth?—I should certainly think Dungeness the most elegible.

Do you understand my question to mean for building a harbour?—I have heard that was the object.

Why would you prefer Dungeness?—As a protection in south-westerly gales.

I am assuming the building of a harbour, for instance, in addition to what there is at present, either at Dungeness or at Dover, or anywhere else; what place would you recommend for constructing a harbour?—For some reasons I think Dungeness, for others Seaford, according to the different winds, or Newhaven.

What do you mean by according to the different winds?—For the easterly winds and the north-easterly winds, I think ships that could not get into Dungeness roads or harbour, supposing one there, might go away to Seaford.

(*Sir Howard Douglas.*) Where would you propose to build a close harbour?—I think at Dungeness.

For what reason would you prefer Dungeness?—Because when a vessel is in the lower part of the Channel, there is plenty of room to heave a ship to; and I think a prudent man would not run up to Dungeness in bad weather. It is only in the event of his being caught there that he would run in.

In asking about the navigation of the Channel, we suppose vessels either at Beachy Head or Dungeness, or anywhere else, to feel the necessity of a port of refuge in the common ordinary traffic of the Channel; and therefore, in that common ordinary traffic, what part would be recommended as the most likely to be convenient to the trade?—I should certainly say Dungeness. Southerly and westerly gales we dread more than any other. If a ship is above Beachy Head, with a westerly gale, she could not get down Channel again, and with a flood-tide drive up to Dungeness very nearly; and probably the captain would be afraid to run to the Downs, but put into Dungeness, supposing a secure harbour there.

What would make him afraid to run to the Downs?—Because nine people out of ten, I think, become nervous when they get into that part of the world. They have such a dread of the Goodwin Sands.

Suppose the vessel which you speak of to be to the westward of Beachy Head?—He is not obliged to run then, I think.

What would he do?—It would be better to heave to.

Would you have a vessel lying two or three days in the Channel in a gale of wind?—There is now and then a gale of that kind, but, generally speaking, violent winds are not of such long duration. I have never met with the slightest accident in the Channel, and I have always found the safest thing to be to heave to in good time.

Dungeness is already a good roadstead for ships in a south-west wind?—Yes, and capable of great improvement, I think. The Spit is making out much to the eastward, and I see sometimes 100 sail there lying at anchor, and a breakwater might make it secure, I think.

Do you mean secure against a sudden change of wind?—I am afraid that is a very difficult thing; but I think when a vessel cannot ride at Dungeness, another harbour at Newhaven, or Seaford, might protect her against the easterly winds.

Do you prefer a harbour of refuge to the eastward or westward of Beachy Head?—To the westward of Beachy Head; at Seaford, I think.

Why to the westward?—Dungeness would protect them in westerly winds, and Seaford in easterly winds; besides which a vessel wind-bound could always get out in case of a certain gale from the eastward, as wind-bound ships do from Ramsgate.

(*Admiral Dundas.*) In the event of war, would it be necessary to have a harbour on the coast of Kent where war-steamers could be sheltered from all winds and weather, and constantly ready, night and day, to slip out at a moment's notice for the protection of the trade of the coast; and, combined with that object, that of being a harbour of refuge for merchant-vessels, and what spot on the coast of Kent from Beachy Head to the North Foreland would you say was the most prominent part to form such a harbour, remembering at the same time that it would be necessary to have a harbour where troops could embark and expeditions be sent out at a few hours' notice?—I should prefer Dungeness.

Have you any particular objection to Dover as a place for constructing a breakwater?—I think Dover bad, because in bad weather a ship might be near the Goodwin Sands.

You are aware that it is supposed you still have Dungeness, and a second port of refuge at Dover?—Yes.

Do you think that ships would be safe in the Downs if there was a war to-morrow and the enemy had steamers in the Channel?—I should think they would be safe for our steamers would be as good as theirs.

Would a squadron of steam-vessels at Dover be nearer at hand to protect merchantmen in the Downs than if you had them at Dungeness?—Yes; a steamer can ride anywhere.

Captain *Geo. Richardson.* 20th June, 1844.

If you had a harbour of refuge at any place, would you construct it on a spot where they would give more protection to the commerce of the country than any other?—One would think so; but, as a merchant-man, I am for Dungeness?

As a sailor, if you are ten leagues to the westward of Beachy Head in a heavy gale of wind, and you wanted anchorage, if you had a harbour of refuge off Seaford, and another to the eastward of Beachy Head, which would you run to?—I should go to the one to the eastward.

If bad weather came on at night, would you go to the eastward of Beachy Head in a gale of wind, or, if there was a good breakwater in Seaford Roads, would you go there?—I should prefer going to the one to the eastward. I should not like to go down on a lee-shore, which would be the case in a S.W. gale at Seaford.

Do you know anything of the anchorage at the eastern side of the Head?—No.

Are you aware there are rocks there?—Yes.

Have you ever anchored off there?—Never.

What is your objection to going into a port in a gale of wind?—It must depend on my locality.

You said you had an objection to going into a port in a gale of wind?—I think there is a great risk in a heavy gale of wind in running for a port.

(*Captain Fisher.*) Do you object to ports of refuge generally?—Decidedly not.

Where, in your opinion, would be the most desirable position to construct an asylum harbour between the mouth of the Thames and Plymouth, to be accessible at all times of tide for ships of all classes, men-of-war, armed steamers, and large merchant-ships, and calculated also, in the event of hostilities, for giving protection to the trade generally, both outward and inward bound, as may be?—Seaford or Dungeness.

Do you think Seaford would give protection as a harbour of refuge?—I think it would.

Are you of opinion that large ships or convoys seeking shelter or detained by contrary winds could make their passage from a harbour constructed at Dungeness in all winds and under all circumstances, when they could not make their passage from a harbour constructed off Dover?—I should think they certainly could. There is a great advantage in being down off Dungeness. Many persons would not like to start from Dover; of course I mean with a contrary wind, as from the Downs, outward bound. I think Dungeness would be much preferable.

Are you aware of the course a ship would have to steer from a harbour constructed off Dover to round Dungeneess?—Yes; about W.S.W., I think it is.

How would she have to steer from a harbour constructed off Dungeness to round Dungeness point?—If the entrance is south-east, she may go as close round Dungeness as she likes. She must go a little to the southward.

If the course from a harbour constructed at Dungeness would be more to the southward than one constructed off Dover, how would ships be able to make their passage down in a wind which would otherwise be favourable?—I suppose the tide would take them round the point fast enough.

The question is, whether vessels lying in a harbour off Dover could make their passage down Channel with such a wind as they might not be able to make with a harbour constructed off Dungeness?—Supposing both of them must be to the southward—I mean the entrances.

Have you ever anchored in Dover Roads?—Yes; and the water is rather deep as far as I recollect.

(*Captain Washington.*) Having commanded a merchant-vessel some years, will you give your free and unbiassed opinion at what spot between the Nore and the Bill of Portland you think that a harbour of refuge would be most useful to merchant-vessels, taking all winds and weather into consideration?—I have stated Dungeness as far as my opinion goes; but I do not think that I am very competent to give one.

Is that your opinion, having commanded a ship a great many years?—Yes.

As a seaman, you prefer Dungeness?—Yes.

If a breakwater was to be erected on the east or west side of Beachy Head, which would you prefer?—Seaford Roads, having one also at Dungeness.

Do you propose to have a harbour on each side of Dungeness for every wind?—No; one at Seaford for easterly and southerly winds and one at Dungeness for westerly and southerly, &c. There would be no objection to one on each side; but it is not of so much consequence with easterly winds, because if you cannot hold on with an easterly wind, you can go down Channel. My father and I, some years ago, got up as high as Folkestone; and my father, commanding, although he had been at sea very many years, was not acquainted with the anchorage, and went back to Portsmouth.

[*The Witness withdrew.*]

Adjourned.

Appendix A.

LETTERS, REPORTS, &c., RECEIVED.

Page

1. Treasury Minute, respecting the objects to which the attention of the Commission was to be directed.—*April* 2, 1844—(See page 3.)
2. Mr. Trevelyan to Sir Byam Martin, notifying the members composing the Commission.—*April* 10, 1844
3. Sir William Symonds to Sir Byam Martin, requesting that charts may be procured and a survey made of Dungeness.—*May* 3, 1844.
4. Sir John Barrow to Sir Byam Martin, notifying that the Lords Commissioners of the Admiralty had directed the first-lieutenant and surveying officer of Her Majesty's ship *Blazer* to make the required survey of Dungeness.—*May* 4, 1844.
5. The Registrar of the Cinque Ports to Sir Byam Martin, respecting the letter of his Grace the Duke of Wellington, directing officers of the Cinque Ports to render any assistance required by the Commission.—*May* 11, 1844.
6. Lord Lincoln to Sir Byam Martin, in reply to his letter of the 28th May, that the lease of the Crown Quarries at Portland had been already agreed upon.—*May* 31, 1844.
7. Mr. Faraday to Sir Byam Martin, respecting the action of sea-water on iron . . 198
8. Mr. Brunel to Sir Byam Martin, in reply to a communication requesting his opinion on the best section for the sea slope of breakwaters 198
9. The Chairman of the Ship Owners' Society to Sir Byam Martin, in reply to his letter of 14th July, stating his willingness to attend if required, but suggesting that he would not be able to give much information on the matters upon which the Commission is engaged.—*July* 16, 1844.
10. The Chairman of Lloyd's to Sir Byam Martin 198
1. Captain Washington's Report on Dover Bay, Dungeness, Eastbourne Bay, Newhaven, and Seaford Road, with the Instructions 199
12. Captain Washington's Report on the Holding-ground in Dover Bay, with Instructions . 203
13. Captain Sheringham's Instructions and Report of a Survey at Portland . . . 205
14. Lieutenant-Colonel Harry Jones, R.E., on Sea Slopes 206
15. Mr. Stuart's Report on Plymouth Breakwater 208
16. Captain Washington's Report on the Memorial of the Mayor and Corporation of the Borough of Harwich 208
17. Proposition for Harbour at Dover by Captain Vetch, R.E. 210
18. Captain Washington's Report on Eastbourne Bay, on the Water in Dover Bay, and on the nature of the Bottom off Dungeness 213
19. Mr. Phillips's Report on the examination of the Water in Dover Bay.—*July* 12 . . 215
20. Mr. Phillips's Report on a second quantity of Water from Dover Bay.—*July* 25 . . 215
21. Mr. Phillips's Report on the nature of the Silt in Dover Bay.—*August* 2 . . . 216
22. Extracts from Paper by Mr. William Walker, Plymouth 216
23. Mr. Walker's Reply to Queries by Sir Byam Martin 217
24. Mr. J. Sparrow, Collector of Customs at Rye, respecting Dungeness.
25. Mr. K. B. Martin, on the Deposit of Silt in Ramsgate Harbour.

    Sir John Rennie, Plan and Report on the Brake and Goodwin Sands, addressed to the Trustees of Ramsgate Harbour.—*March* 15, 1842.
26. Captain Sir Samuel Brown, relative to the action of the worm on wood piles . . 217
27. Paper relative to the action of sea water on iron and bronze—from guns, &c., recovered from the Royal George, Edgar, and Mary Rose 219

Appendix A.

Letter from Mr. Faraday respecting the action of Sea Water on Iron.

Mr. FARADAY TO SIR BYAM MARTIN, RESPECTING THE ACTION OF SEA WATER ON IRON.

Royal Institution, June 12, 1844.

Sir,

I hasten to reply to your note, though not, I fear, with any very certain knowledge, for infirm health has prevented me from taking up the consideration of the action of sea-water on iron so practically as I should have liked to have done; but I will give you my opinion and views as far as my observation and judgment will permit. I conclude that the question is of cast-iron in sea-water. Between these two bodies there is a vigorous action; as far as I have been able to observe, it is greatest in the water near the surface, less in deep water, and least of all where the iron is buried in sand, or earth, or building materials, (into which the water may penetrate); for then the oxide and other results formed, are detained more or less, and form, sometimes, a cement to the surrounding matter and always a partial protection. Soft cast-iron, as far as my experience goes, (which is not much,) corrodes more rapidly than hard cast; and the soft, gray, and mottled iron, more rapidly than the brittle white iron. As to the amount of corrosion in any given time, I have nor had the opportunity of observing any good and satisfactory cases of illustration.

In estuaries and the mouths of rivers, it is very probable that great differences of corrosion will arise from the different circumstances of variable saltness, the soil of the river, if near a town, the matters brought down by the waters, &c., &c. The association of iron also with other substances, if metallic, will much affect it; thus a wharf of cast-iron might occasionally be greatly injured by making fast to it vessels that are coppered using iron cables.

As to the protection of iron, and first by a coating: the permanency of a coat of paint, or of tar, or bituminous matter, can only be ascertained by reference to experience; of this I have none; except that in a case where coated iron sheathing for ships was brought to me, I was much impressed with the very thorough adhesion of the coat to the iron; the process was patent, and I cannot remember whose it was. Zinced iron would no doubt resist the action of sea-water as long as the surface was covered by zinc, or even when partially denuded of that metal; but zinc dissolves rapidly in sea-water, and after it is gone, the iron would follow.

As to voltaic protection, it has often struck me that the cast-iron piles proposed for lighthouses or beacons might be protected by zinc in the same manner as Davy proposed to protect copper by iron; but there is no doubt the corrosion of the zinc would be very rapid. If found not too expensive, the object would be to apply the zinc protectors in a place where they could be examined often, and replaced when rendered ineffective; in this manner I have little doubt that iron could be protected in sea-water. It is even probable that, by investigation and trial, different sorts of iron might be easily distinguished and prepared, one of which should protect the other; thus soft cast-iron would probably protect hard cast-iron; and then it would be easy to place the protecting masses where they could be removed when required.

Hence though iron be a body very subject to the action of sea-water, it does not seem unlikely that it might be used with advantage in marine constructions intended to be permanent, especially if the joint effects of preserving coats and voltaic protectors were applied. Perhaps engineers are in possession of practical and experimental data sufficient to allow of the formation of a safe judgment on this point; for my own part I am not, and therefore am constrained to express the above opinions with much doubt and reserve.

I am, Sir,
Your very obedient faithful servant,
W. Faraday.

Sir T. Byam Martin, G.C.B.,
&c. &c. &c.

Extract of Letter from Mr. Brunel on the subject of the Sea Slopes of Breakwaters.

EXTRACT OF A LETTER FROM Mr. BRUNEL TO SIR BYAM MARTIN, ON THE SUBJECT OF THE SEA SLOPES OF BREAKWATERS, *Dated* 19*th June*, 1844.

"Upon one point upon which I understand the Commissioners to have sought an opinion, I have no hesitation in expressing my concurrence in those which I am told have been generally expressed in favour of vertical sea-walls, in lieu of slopes, where the nature of the material to be used, and other circumstances, admit of such a plan being efficiently and economically carried out."

(Signed) I. M. Brunel.

Letter from the Chairman of Lloyd's to Sir B. Martin.

THE CHAIRMAN OF LLOYD'S TO SIR BYAM MARTIN.

Sir,

Lloyd's, June 26, 1844.

I have the honour to acknowledge, with my best thanks, your letter, dated 19th instant, requesting to be informed, if I wish to state, as chairman of the establishment, the opinion entertained by myself or others, as to the most suitable position for harbours of refuge on the south-east coast of the British Channel, and to acquaint you it has been submitted to the Committee for managing the affairs of Lloyd's, and I am happy to state that they entirely concur with me in a perfect conviction, that the parties interested in British shipping will receive every consideration in the selection of suitable positions for harbours of refuge from the Commission appointed for that purpose by Her Majesty's Government.

I have the honour to be, Sir,
Your most obedient servant,
G. R. Robinson.

Sir T. Byam Martin, G.C.B.
&c. &c. &c.

INSTRUCTIONS FOR CAPTAIN WASHINGTON.—POINTS FOR EXAMINATION.

Harbour Commission, Gwydyr House,
April 18, 1844.

DOVER.

To anchor the *Blazer* at six fathoms low-water spring-tides in front of the centre of Dover bay, and ascertain the distance this will give from the beach.

To sound and ascertain the depth of water within that position and the quality of the bottom as to holding-ground, or if any rock or overfalls be included within that space. State the soundings on a chart, but describe the nature of the bottom

When anchored in the position pointed out, sound at short distances inward towards the shore, with four hand-leads put down at the same time, at about 12 feet distance from each other, in order to ascertain, as far as may be practicable, if the bottom shelves away suddenly so as to make an uneven surface for caissons, to be placed, as suggested by Mr. Cubitt, which, if standing on an inclined plane, might have an inconvenient leaning outward.

To ascertain if the anchorage above pointed out places the ship in the true run of the tide, also at what rate the tide runs, and at what distance from the pier-head does the tide take a straight course up Channel.

The bearings of the head-lands from the position mentioned.

The depth of water at low-water spring-tides at a distance of 200 yards from the shore, and again at 400 yards.

It having been asserted before a Committee of the House of Commons that a fixed breakwater at Dover (such as described by Mr. Cubitt) would cause the harbour to be choked up, it is highly necessary this assertion should be proved or contradicted by a most careful examination of the set of the tides, and by every possible means as to the probability or possibility of an objection, which, if true, must be so fatal to improvement at that port.

The words of the witness alluded to are as follows :—

"No harbour should be made there (Dover) by a fixed breakwater, because the diluvial matter passing up there would soon choke the harbour. All the diluvial matter that is passing up from the Ridge and the Varne runs round Dover, then passes up towards Sandwich, and gets through the Gull Stream, fortunately, otherwise that passage would be choked up."

It is commonly understood, and all printed sailing directions for the Channel tend to confirm the opinion, that the flood-tide in the offing takes a direct course up Channel; it is therefore important that every effort should be made to ascertain if at any time of tide it takes so eccentric a direction as to run at right angles with the course of the Channel, and thus to carry diluvial matter from the Varne and Ridge shoals to Dover.

It is desirable, with reference to this assertion, to prepare a small chart, showing the position of the Ridge and Varne with respect to Dover, to include the South Sand Head, the South Foreland, and that part of the coast of France nearest to the Ridge and Varne.

Also to sound about the Varne, the nearest shoal to the English shore, and ascertain if the diluvial matter, as it is termed, corresponds with the soundings in Dover Bay.

BEACHY HEAD AND EASTBOURNE.

To sound and carefully ascertain the quality of the bottom within the breakwater, proposed by the late Harbour of Refuge Commission to the eastward of Beachy Head.

To ascertain the set of the tide in that position, and to learn from fishermen, &c., every particular about the accumulation of shingle at that spot, and if the shingle is known to accumulate there with any other but south-west winds, and to what degree it increases at the worst times.

There is a nine-feet shoal described near to the proposed harbour, the exact extent of which must be ascertained in order to see if it renders the approach dangerous.

To ascertain at what distance from the shore there is a depth of six fathoms at low-water spring-tides; and what are the depths from thence gradually inward to the shore.

NEWHAVEN AND SEAFORD BAY.

What is the distance seaward from the pier-heads into six fathoms at low-water spring-tides, and also to a depth of three fathoms water.

If there are any shifting sands about the mouth of the harbour.

The bearings of the head-lands when in six, and when in three fathoms water.

To ascertain the set of the tides and their strength when anchored in those positions.

The soundings and quality of the bottom between the anchorage and the pier-heads.

To examine the shore in front of Seaford to see if it is suitable and favourable to the construction of an artificial harbour.

To make such observations generally respecting the above-mentioned places as may be useful for the information of the Commission when they arrive on the spot.

The officers employed in making the observations required will be examined before the Commission.

(Signed) T. BYAM MARTIN, *Chairman.*

Appendix A.

Report of Capt. *Washington*.

REPORT OF CAPTAIN WASHINGTON.

Her Majesty's Ship "Blazer," Harwich, April 29, 1844.

Sir,

In compliance with your instructions, I beg to state that I proceeded to Dover, Newhaven and Seaford Bay, Beachy Head and Eastbourne Bay, and having been much favoured by fine weather, have been enabled to examine into all the points referred to in your memorandum of the 18th instant.

DOVER.

Dover.

Dover Bay has been thoroughly sounded by us as far out to seaward as the 10 fathoms edge, and the depth of water, quality of bottom, set of tides, and eddy, are shown in the accompanying chart on the scale of twelve inches to a mile, nearly, made by Lieutenant Cudlip, and Mr. E. K. Calver, master, assistant surveyors of Her Majesty's ship under my command.

Anchorage.

From this chart, it appears, that a vessel anchored in six fathoms at low-water springs, in front of the bay, would be at the distance of 930 yards from the shore, or rather less than half a nautic mile; that

Bearings.

the bearings of the head-lands from such a position would be, the South Foreland, east north-east; Folkestone, west a quarter south; and Dungeness, west by south half south: the quality of the

Quality of bottom.

surface of the bottom, as shown by the arming of the lead, between this spot and the shore to the westward, would be dark sand and broken shells; opposite the valley, mud with 'ross' or worm-casts; whilst to the eastward of the Castle Jetty it is chiefly chalk. The only shoal within this

Shoal.

space is one of small extent, having ten feet water over it, about 300 yards off shore to the eastward of the Castle Jetty; the depth of water in the middle of the bay at 200 yards from the shore is eight feet, and again at 400 yards, 12 feet.

Slope of bottom.

The slope of the bottom in a section run off at low-water mark from Cheeseman's Head was found to be as follows:—

At 100 yards,	being the	1	fathom	edge,	1 in 50,
150	„	„	2	„	1 „ 25,
175	„	„	3	„	1 „ 12,
200	„	„	4	„	1 „ 12,
225	„	„	5	„	1 „ 12,
Making the general slope			. . .		1 „ 22,

and supposing Mr. Cubitt's proposal to be carried out, of placing caissons of 100 yards in length each,—the first would require a slope of 1 in 50, and the second of 1 in 15, but, of course, under the circumstances, of so abrupt a descent, an engineer would modify the length of his caissons accordingly.

Tides.

The anchorage in six fathoms water is in the fair stream of tide, both on the flood and on the ebb, and the rate of the tide is about three knots on springs, and one and a half on neaps. We took advantage of a very calm day to set three buoys adrift at different distances from the shore, and found that, on the westerly or ebb-tide, there was no eddy even at one cable's length from the shore; but on the flood, or easterly going tide, an eddy is caused by Cheeseman's Head, which extends about a quarter of a mile from the beach in the bight of the bay.

Shingle.

Except at the bar at the entrance of the harbour, the shingle in no case was found to extend below low-water mark, and in many places not so far.

In watching attentively the movement of the shingle on the beach, it appears to be impelled forward entirely by the action of the waves; the stream of tide, even in its greatest strength, has no influence on it, and as the prevalent wind is westerly, and that is also the point of greatest exposure, the greater part of the shingle travels from the westward; if therefore an opening were left between the shore and any pier or breakwater that might be placed hereabouts, the shingle would be forced in by the waves, and having no impulse to carry it forward it would remain and rapidly increase.

Necessity of connecting the piers with the shore.

In like manner, if the eastern end were not connected with the shore in addition to some increase of shingle, the eddy on the flood-tide might tend to bring in at the opening, and deposit in the still water within, any silt or other matter which the tide-stream might hold in suspension.

The movement of the shingle then, and the set of the tides are both in favour of piers connected with the shore at each extremity of the harbour.

Varne and Ridge.

With respect to the "diluvial matter from the Varne and Ridge being carried into Dover Bay," as stated in evidence before the Shipwreck Committee, it would hardly seem necessary to disprove so random an assertion; but as your instructions especially call my attention to this point, we visited the sands in question and got about a dozen casts of the lead, well armed, at different spots along the length of the shoal, the result is that the quality of the bottom differs considerably from that at Dover;

Quality of bottom.

at the Varne it is light-coloured coarse sand and large broken shells, while in Dover Bay the surface of the bottom is dark sand and mud with numerous worm-casts.

Direction of shoals.

It may be added, that the general trending of the shoals is, as might be expected, directly with the fair stream of the main Channel tide which sets north-east; that Dover bears from the centre of the Varne north, eight miles distant, and that the Channel between them is from 18 to 20 fathoms in depth; moreover it is a well-known fact that the Boulogne fishermen, who sometimes leave their nets anchored on the Varne and Ridge, find them, if broken adrift by a gale, on the beach between Cape Grisnez and Calais, at a spot full 20 miles south-east of Dover Bay.

Area of harbour proposed in 1840.

The space included within the lines of breakwater, as proposed by the Harbour Commission of 1840, is about 270 acres without the three fathoms line, or bare anchorage for 100 vessels; but should it be decided to make a harbour in this bay, nature seems to have pointed out a most favourable flat in seven fathoms water, forming a considerable sweep to the southward, on the outer edge of which it might be desirable to place the southern breakwater; the trending of this seven fathom edge towards the beach, as you advance to the eastward, also favours the carrying the eastern pier about one-third of a mile nearer the South Foreland, whereby double the area of excellent anchoring ground would be rendered available at but little additional expense.*

* Should such a proposal be carried out, the present harbour might be converted into a basin or floating docks by a caisson, or by lock-gates at the entrance, and the small stream which now falls into the harbour be turned out either to the eastward or to the westward of the breakwater.

Area of existing harbours.

It may serve, perhaps, as a useful point of comparison, with respect to dimensions, if I mention, in round numbers, the relative areas of a few roadsteads and harbours.

Roadsteads.	Acres.	*Harbours.*	Acres.
Yarmouth Road	8,000	Milford Haven	1,000
Hollesley Bay	3,000	Portsmouth	200
The Great Nore	4,000	Plymouth Hamoaze	400
Margate Road	2,500	Sheerness	1,500
The Downs	7,000	Harwich	700
The Little Downs	1,000	Dartmouth	120
Dungeness East Bay	3,000	Falmouth	300
Spithead	2,500	Kingstown	180
Plymouth Sound	800	Cove of Cork	1,700
Cherbourg	1,900	Ferrol	1,700
Rochefort (Basque Roads)	16,000	Cadiz	2,500
Brest	7,500	Port Mahon	400
Toulon	800	Malta	400

BEACHY HEAD AND EASTBOURNE BAY.

Beachy Head forms a bold promontory, offering good shelter in Eastbourne Bay from westerly gales. The apparent chief difficulty to contend with in making an asylum harbour here would be the sand lying immediately under Beachy Head, named Holywell Bank, or Sand-acre, which has at one spot only nine feet water on it at a distance of 600 yards from the shore. This bank materially tends, however, to prevent the weight of the sea setting home into the bay, so much so that I am assured by the officer of the Coast Guard, and by several fishermen residing here, that no instance is known of their being unable to beach their boats in Eastbourne Bay in a south-west gale; nor in the course of 12 years have more than three vessels grounded on this bank. In consequence of its position, any detached breakwater which it may be proposed to erect here must be carried as far to the eastward towards Langley Point as can be done consistently with securing a good entrance at the eastern as well as western end. The tides set fairly through the bay, both on flood and ebb, at the rate of two knots on springs and one on neaps.

Holywell Bank or Sand-acre.

Tides.

The shingle here comes chiefly from the westward, and with a south-west gale heaps up to the extent of several feet as far as the Beach Houses at Eastbourne; but it is going away at the Grand Redoubt, and to the eastward where the sea is gaining on the shore. A great fall of the cliff at Beachy Head, in November last, has stopped the progress of the shingle of late, and probably some groynes judiciously placed would arrest the encroachment of the sea on the eastern beach.

Shingle.

The distance from the shore to an anchorage in six fathoms low-water springs in the middle of the bay is rather more than one mile (2200 yards), and the water gradually shoalens to the beach; the bottom is of mud, sand, and shells, and is spoken of by all seafaring men here as good holding-ground off Eastbourne and Pevensey, but has foul ground without.

Anchorage.

The bearings of the headlands from the anchorage in six fathoms would be Hastings, east half north 10 miles; Beachy Head, west by south 3 miles; thus it will be seen that the roadstead is open for the whole southern board of the compass.

The Grand Redoubt and some Mortella towers might protect the in-shore part of the bay, but probably would not be sufficient protection for the outer part of the anchorage.

Defences.

One great objection, however, to bringing vessels in bad weather into this bay would be the rocky shoals, named the Royal Sovereign and the Horse of Willingdon; on one spot of the former, it is said, there are only 10 feet water, lying three miles and a-half south-east by east of the centre of the anchorage; but these, perhaps, might be well buoyed, or even the chalk rock blasted or cut away.

Shoals.

By way of comparing this with other localities, I may state that a breakwater in Eastbourne Bay two miles long, including cants at each end, constructed in seven fathoms at low-water springs, would enclose an area of 800 acres without the three fathom edge, and 900 acres without the two fathom edge, or sheltered anchorage for about 300 sail; but it would be difficult to place such an erection in any position in which a ship would not risk getting into very shoal water on entering or leaving by its eastern opening, or of getting entangled by the more dangerous rocky shoal of the Royal Sovereign, in the very possible event of missing the port when running for it in a south-west gale and thick weather.

Area.

NEWHAVEN AND SEAFORD ROAD.

The tidal harbour of Newhaven lies upon a nearly straight coast about eight miles to the westward of Beachy Head; the distance from the pier-heads into three fathoms water is 1000 yards, and to the six fathoms edge 1570 yards, or three-quarters of a mile; the genera lslope of the ground is 1 in 130.

Slope of bottom.

To the 1 fathom edge the slope is 1 in 180,
„ 2 „ „ 1 in 140,
„ 3 „ (at 1000 yards) 1 in 170,
„ 4 „ „ 1 in 60,
„ 5 „ „ 1 in 60,
„ 6 „ „ 1 in 170,

at a distance of 1570 yards from the beach.

The bottom, off the harbour, consists of sand and broken shells and mud, over chalk, but has good holding-ground farther to the eastward throughout Seaford Bay.

The bearings of Seaford Head, from an anchorage in three fathoms water, would be south-east a quarter east, and it shuts in Beachy Head. Brighton Cliffs, the extreme western land, north-west a half west. From an anchorage in six fathoms water, Beachy Head, with the light just open, bears south-east about eight miles; Seaford Head, south-east a half east, two miles and a-half. Brighton Cliffs, the extreme western land, north-west a quarter west.

Bearings.

Thus the bay is entirely exposed from north-west round westerly to south-east, and well sheltered for the other half of the compass.

APPENDIX A.

Report of Capt. *Washington.*

A breakwater in Seaford Bay one mile long, slightly curved to the southward, placed in six fathom water, and a pier of the same length nearly, run off in a south direction from Barrow Head, with an entrance at the south-west angle, would shelter, without the three fathoms edge, an area of 370 acres; and without the two fathoms edge a space of 470 acres, or anchorage for 180 vessels.

Breakwater. Newhaven.

At the entrance of the tidal harbour of Newhaven, I am told by the officer of the Coast Guard, and the pilots, that at low springs the shingle-bar now dries out to the Black Buoy, as laid down on the chart, or 50 yards from the pier-heads; but there are no other shifting sands or banks.

Shingle.

The shingle is not very great hereabouts, but is, as usual, brought up by a westerly gale, and forms a bar at the mouth of the harbour; a groyne is now being run out for the protection of the entrance to a distance of 100 yards from low-water mark.

Newhaven Harbour valuable.

I must, however, state that the harbour seems to be of considerable value, and, owing to its powerful back-water, possesses facilities for further improvement; the piers should at once be widened, as at present there is only a width of 108 feet, and if they could be extended about 500 yards into 12 feet at low-water spring-tides, and the space within dredged gradually to that depth, Newhaven might afford, at no great expense, a valuable depôt for coaling and refitting steamers.

Seaford Road.

In Seaford Road, from position a very important place, the line of six fathoms water is in the fair set of the Channel tide, but within the three fathoms edge an eddy on the flood turns to the westward off Seaford Head, at one hour and three-quarters before high water by the shore, and is of great assistance to vessels making the harbour with a scant westerly wind.

Barrow Head.

In the possible event of a breakwater or pier being proposed in Seaford Road, I may mention that Barrow Head, a cliff of about 300 feet high just to the westward of the harbour, is of chalk, capped with a coarse sandstone, all of which might, perhaps, be available for forming a core or nucleus for such an erection; the lowering this headland would also much benefit the navigation of vessels entering and leaving the harbour, as with the wind to the westward it becalms their sails at the moment they require the whole of their headway to shoot out or in between narrow piers, with a tide running directly across them.

This, Sir, I trust completely replies to your instructions, to which I am much indebted for suggesting many points that otherwise might have escaped my attention.

Brake Sand.

As the subject of the extraordinary change of position in the Brake Sand, off Ramsgate, has been much discussed, I felt it my duty to examine it, as far as my limited time would allow me, and for this purpose obtained from Captain Beaufort, hydrographer to the Admiralty, the original drawing of the survey of the Downs by Græme Spence in 1795, and that of Mr. Thomas, R.N., in 1832; and on these original documents, and on their own points, I laid down the angles that we observed in April, 1844, all which prove, as I had fully anticipated, that Captain Bullock's recent chart of this sand is perfectly correct as to its position; that the Brake Sand has gradually moved bodily to the westward, the four fathoms edge having, in 1832, moved about 500 yards, and in 1844 as much as 100 yards more, making a total move of 600 yards in the space of 50 years; perhaps, considering its position, one of the most remarkable changes of a body of sand on record; but in spite of these changes, I see no reason why the Brake should not be fixed by a skilful engineer in its present position, and thus converted from an evil into a benefit.

Has moved to the westward.

In conclusion, I beg to add that Captain Bullock's excellent charts of all these parts, prepared for the Harbour Commission of 1840, have been invaluable to me in my brief inquiries, and I feel convinced that they will prove so to the present Commission in its more detailed examination.

I am, Sir,

To Admiral Sir T. Byam Martin, G.C.B. Your obedient servant,

&c. &c. &c. JOHN WASHINGTON, *Captain.*

Report on Dungeness.

REPORT OF CAPTAIN WASHINGTON ON DUNGENESS AND FOLKSTONE.

H. M. S. Blazer, Dover Bay, May 13, 1844.

Dungeness forms a remarkable shingle point, projecting in a south-south-east direction four miles beyond the fair line of the coast, making a natural breakwater of low land, affording shelter in the east bay from north round westerly to south-west by west; and in the west bay from north round easterly to east, or for 19 points of the compass.

Chart.

Dungeness East and West Bays have been thoroughly sounded during the past week to a general distance of three miles off shore; and the depth of water, quality of bottom, set of tides and eddy, are shown in the accompanying chart on the scale of $1\frac{1}{4}$ inches to a mile, nearly, by Lieut. Cudlip and Mr. E. K. Calver, master, assistant-surveyors of Her Majesty's ship under my command.

On comparing this examination with the Admiralty published chart of this locality of 1809, it appears that during the past 35 years the general soundings have altered but little; in the East Bay, immediately to the eastward of the Ness, the four fathoms edge of the "Roar Bank" has grown out about a quarter of a mile, but to the eastward of the "Roar Spit, or Newcome Buoy," it returns to the old line, which it pursues as far as 10 miles from the Ness, when it trends sharply half a mile in shore towards Hythe, and thus continues till it falls into the rocky beach at Folkestone; its average extent to the four fathoms edge is a mile and a half from the beach at Dymchurch.

Small change in the East Bay.

West Bay.

In the West Bay the four fathoms edge has gradually inclined in-shore till off Rye, at five miles from the Ness, where the flat has decreased fully half a mile.

Swallow Bank.

Chapel Bank.

The great change, however, is in the two shoals of "Swallow Bank," three miles to the eastward, and "Stephenson's" or "Chapel Bank," three miles and a half to the westward of the Ness; Swallow Bank has decreased from a mile to half a mile in extent within the four-fathom edge; and Stephenson's Bank from two miles to only one mile long, and narrowed to a quarter of a mile; while the depth of water on the former has increased from 16 to 22 feet at low-water springs.

These changes appear so material, without any visible cause, that it is right to state that possibly the survey of 1809 was only cursory, having been made during the common course of service in war time.

Tides.

The rise of tide at Dungeness is 22 feet on springs, and 13 on neaps, being the largest rise along this coast. The tide-stream, both on flood and ebb, sets past the Ness and fairly through the bay along the seven fathoms edge, at the rate of two miles and a half an hour on springs, and one mile and a half on neaps, gradually decreasing to half this strength as you approach the shore into the three fathoms edge.

Quality of the bottom.

The quality of the bottom in both bays is fine sand over clay and mud, and excellent holding-ground

Report of Capt. *Washington.*

throughout; and I am told by the pilot, that in westerly gales he has seen 300 vessels at anchor well sheltered in the East Bay.

From all the information I can gain, the shingle on this beach, as elsewhere, is moved to the eastward or westward according to the gales of wind, and as the prevalent winds are westerly the chief movement of the shingle is from the westward; from careful measurements it appears that the distance from the centre of the lighthouse to the nearest point of low-water mark at spring-tides is 190 yards, to the Eastern Ness 400 yards, and to the Western 433 yards. Now, a valuable inscription inside the lighthouse records that the present building was erected in 1792, at 100 yards from the sea, consequently the beach has grown out a direct distance of 90 yards in 52 years, or about five feet a-year; the Eastern Ness has in the same period increased 50 yards, and the Western 100 yards in extent, judging from the Admiralty chart by Græme Spence.

Movement of the shingle.

Increase of beach.

From the top of the lighthouse the view extends over a waste of shingle covering an extent of about six square miles; it is furrowed throughout as the waves of the sea, giving the idea that each ridge marks the period of a very heavy south-west gale of wind. The width between these ridges varies materially, but they average about 20 yards apart.

Perhaps I may be permitted to say that I was most forcibly struck with the perfect order of the light apparatus and everything connected with this establishment; the recent alterations have added materially to the efficiency and comfort of the lighthouse, and the perfect cleanliness of the reflectors and every part of the building, and the comforts provided for the lightkeepers, even to books furnished to their library evince the paternal care of the corporation under which the lighthouses are placed.

Perfect state of the lighthouse.

On the chart I have, for the sake of comparison, projected in pencil in Dungeness East Bay a breakwater, with its western edge resting on the Swallow Bank, and extending in seven fathoms water two miles in a north-east direction; such a breakwater would enclose an area of 800 acres between the three and the seven fathoms edge, and would give an entrance at each end a quarter of a mile wide, and accessible in all winds and at all times of tide, by night as well as by day.

Area of a projected asylum harbour.

This space would enclose the "Swallow Bank;" but as it would lie close to the south-western pier-head, it is probable that the action of the tide would scour it away to the general depth of five or six fathoms; this, however, is but conjecture, and as the southern kant of the breakwater, in order to obtain shelter from south-westerly gales, must in some measure curve across the set of the tide, it may also be conjectured that a deposit of silt will take place within.

Breakwater.

From an anchorage in six fathoms, about the centre of this space, the following bearings were taken:—

Bearings of land.

Dungeness, extreme point, south-west by west. Folkestone, east-north-east.

Dover Castle and South Foreland, east by north half north.

The nearest point of land at New Romney, north-west, distant one mile and three-quarters; two-thirds of which space is over a flat of less than three fathoms water.

The slope of the bottom, in the line of proposed breakwater, would be but slight; it would follow generally the seven fathoms edge.

Slope of bottom.

Any shore defences in this bay, from their distance, would not be available for the protection of an asylum harbour; a breakwater, if erected, must defend itself.

Defences.

It is said that there is a good supply of fresh water in the tank near the beach in the East Bay, brought by pipes from the interior of the country. The only well we visited had three feet of water in it, and its whole depth was 15 feet; this, however, was at the close of a dry season.

Water.

FOLKSTONE.

FOLKSTONE.

Folkstone has a tidal harbour of 14 acres area, with a dry shingle-bar. The shore abreast is rocky to the extent of half a mile distance, when it drops rather suddenly into eight and ten fathoms water. The harbour has lately been much improved, and a groyne is now being run out from the western pier into eight feet at low water, in order to endeavour to arrest for a few years the progress of the shingle, which here, as elsewhere, advances chiefly from the westward.

I have, &c.

JOHN WASHINGTON, *Captain.*

To Admiral Sir T. Byam Martin, G.C.B.

INSTRUCTIONS FOR CAPTAIN WASHINGTON.

Instructions for Capt. *Washington.*

SIR, *Harwich, June* 5, 1844.

THE conflicting evidence we have had before us, respecting the anchorage in Dover Bay makes it indispensably necessary to have recourse to every means of testing its quality as a holding-ground.

I have therefore to request, on the part of the "Harbour Commission," that you will proceed in the *Blazer* to Dover, in order to try how far the holding-ground is trust-worthy, in the event of the bay being converted into a close harbour for the reception of a fleet of war steamers, and as a harbour of refuge for commercial vessels.

It occurs to me that it may be an effectual way of proving the quality of the bottom if you anchor the ship in six or seven fathoms at low-water spring-tides, and after veering out to the length of cable you would think sufficient to hold her in a heavy gale of wind (perhaps a whole cable, and afterwards a half, or less), then to back the ship by the paddles; and when the cable indicates that the first power of the paddles is felt, to drop the lead over the side, and watch if the anchor starts in consequence of the dragging power applied to the paddles.

The great length of sea practice you have had in the *Blazer* and experience of the power of her engines, will enable you to judge with near accuracy of the rate at which the ship would be going (at the time when the anchor starts) if under way, and thus to form a fair opinion of the quality of the anchoring-ground.

This appears to me the most satisfactory way we can have of trying how far the ground is to be relied upon, and I am sure the members of the Commission will feel, as I do, the utmost confidence in committing to your hands so important an experiment.

You will of course bear in mind that the experiment supposes a ship to be within a close harbour at Dover, where there will be but little if any tide to add to the strain on the cable, or any lifting sea to trip the anchor; the trial ought therefore to be made at a time of slack and smooth water.

APPENDIX A.

Instructions for Capt. *Washington.*

The experiments may be repeated in different parts of the bay, and varied in any manner you may think best calculated to lead to a right conclusion.

It seems desirable that Mr. Iron, an intelligent and experienced seaman, the harbour-master at Dover, ought to be present on the occasion, and join with your able first-lieutenant and master in reporting to you their observations during the experiments.

Ships coming to an anchor generally "round to" to stop their way before the anchor is let go; but in order to test the Dover ground still more severely, you can run in and anchor when the ship is going on at the rate of two or three knots, to see if with this sudden jerk she brings up without dragging more than must unavoidably be the case until the anchor has taken fair hold of the ground.

Having performed this service, it is desirable that the "Blazer" should proceed to Woolwich for two or three days, previously to her being released from further employment by the Commission.

It may be proper to read this letter to your officers, and to Mr. Iron.

I send herewith a letter to Mr. Iron, to request he will attend on board the *Blazer* at any time you may propose.

I am, Sir,
Your very humble servant,
T. BYAM MARTIN.

To Captain Washington,
Her Majesty's Ship "Blazer."

P.S.—The only object in desiring to have the *Blazer* at Woolwich is to examine the master, if necessary, about Dover; you can therefore send the ship to such place as may be best for the convenience of the public service, so that the master may be within reach.

T. B. M.

Report of Capt. *Washington.*

REPORT OF CAPTAIN WASHINGTON ON THE HOLDING-GROUND IN DOVER BAY.

Her Majesty's Ship, "Blazer," Dover Bay,
10th June, 1844.

SIR,

IN compliance with your directions I have the honour to report our arrival in Dover Bay yesterday morning, and having embarked, Mr. Iron, harbour-master, and Captain Russell Manners, R.N., who has been in the habit of paying long visits at Dover during the last few years, we immediately proceeded to carry out the experiments proposed in your detailed instructions, in order to test rigorously the holding qualities of the anchorage in Dover Bay, within the limits of the projected breakwater.

First trial. In the western part of the bay in five fathoms water:—

Let go the anchor, going before the tide at the rate of three knots over the ground; brought the ship up suddenly with half a cable, and found by two fixed objects on shore in line, that she held fast. On heaving up, brought up chalk on the flue of the anchor.

Second trial. One quarter of a mile farther to the eastward, in three and a half fathoms water:—

Let go the anchor, running before the tide at the rate of three knots over the ground; brought the ship up short, with 36 fathoms of cable, and found she held fast. Backed astern, with the whole pow r of the engine, without starting the anchor. On heaving it up, brought up chalky clay.

Third trial. A quarter of a mile farther to the eastward, in five and a half fathoms water:—

Let go the anchor, running before the tide at the rate of four knots over the ground; veered to 36 fathoms of cable; carried away the laniards of the stoppers, and dragged a ship's length before she brought up. On swinging head to wind, backed astern, with the whole power of the engines, without starting. On heaving up the anchor, brought up chalky clay.

Fourth trial. At the extreme eastern limit of the breakwater, nearly under the Cornhill station:—

Let go the anchor, running before the tide, with only 36 fathoms of cable; rate over the ground four knots: dragged about a ship's length, when the anchor held, tearing the cable through the stoppers, and carrying away the new three-inch laniards, passed with racking turns, when she brought up and swung to the tide. Backed astern at full speed without starting the anchor. On heaving up, found the anchor had buried itself to the crown in soft chalk.

Fifth trial. Returning to the westward, half a mile farther off shore, in seven fathoms water:—

Let go the anchor, running before the tide, with 40 fathoms of cable; rate over the ground three knots: ship brought up and held fast; backed the paddles at full speed, when she drove about a ship's length. On heaving up, found the iron stock of the anchor, by which the ship had evidently been riding, carried away in the wake of the fore-lock, but no symptom of a flaw in the work.

Sixth trial. At half a mile farther west, in seven fathoms of water:—

Let go the anchor, running before the tide at the rate of four knots over the ground; dragged the cable through the stoppers, and when the whole strain came on, parted the cable at about 30 fathoms from the anchor. Anchored for the night with the best bower. In the morning, having picked up our anchor and re-shackled the chain, we continued our experiments on the holding-ground in the bay.

Seventh trial. A little west of the Castle Jetty, in seven fathoms water:—

Let go the anchor, running before the tide at the rate of three knots over the ground; run out 36 fathoms of cable, when the ship brought up short, and sallied astern some distance; when she swung head to tide, backed the engines at full speed, without starting the anchor. On heaving up, found that the whole arm of the anchor, up to the crown, had buried itself in soft chalk.

Eighth trial. Just off the harbour's mouth, in seven fathoms water:—

Let go the anchor, running before the tide at the rate of three knots over the ground; run out 36 fathoms of cable, when the ship brought up short, and sallied astern half a ship's length. On heaving up, found that the flue of the anchor had searched deep into chalky clay.

The weight of the anchors with which the above experiments were made was 18 cwt., including the stock; diameter of chain $1\frac{1}{8}$ inches, equal to a 14-inch hempen-cable, the mean breaking-strain of which is 36 tons. The burthen of the *Blazer* is 540 tons.

In all these experiments I purposely veered to less than half a cable, in order to make the trials, under conditions, as similar as possible to those of a ship bringing up in a crowded harbour. On

Report of Capt. *Washington.*

carefully examining the chain after the trials, several links were found bent, thereby proving the unusual strain brought on the cable.

From inquiry of Lloyds' agent and others, at Dover, I find that during the late heavy east and north-east gales, upwards of 100 vessels rode them out at anchor in Dover Bay; among them the American ship "Lucas," of 346 tons, riding with two anchors down, parted her best bower cable on the 20th May, and on heaving up her small bower, found one fluke broken off. In the same gales, on the 28th May, the bark "Archibald," of Memel, of 300 tons, parted her best bower cable, and brought up with her small bower.

Thus the tough nature of the holding-ground, so much better than from common report I had anticipated, having disabled one anchor and parted the cable from the other, and the fact of two large ships having also parted their cables in the recent gales, appear to me decisive as to the good quality of the anchorage, nor, after the trials I have witnessed, should I have any hesitation in riding out a gale of wind in Dover Bay in its present state; how much less so when enclosed by a breakwater.

I am, Sir,
Your obedient servant,
JOHN WASHINGTON, *Captain.*

To Admiral Sir Byam Martin, G.C.B.,
&c. &c. &c.

P.S. I have read this report to Mr. Wingrove, first lieutenant, and Mr. Calver, master of the *Blazer*, as well as to Captain Manners, R.N., and Mr. Iron, harbour-master, at Dover, and they entirely concur in the statements contained in it.

INSTRUCTIONS FOR COMMANDER SHERINGHAM, R.N.

Instructions for Com. *Sheringham.*

Harbour Commission, Gwydyr House,
May 10, 1844.

SIR,

THE Lords Commissioners of the Admiralty having signified to the Harbour Commissioners that you have received directions to attend to such duties as may be pointed out to you by the Commission, I have, on the part of the Commission, to request that you will proceed in Her Majesty's ship under your command to Portland and Weymouth Roads, and there enter upon a detailed examination of those anchorages, sounding pretty closely as far out as the seven fathom line, and more openly to the 12 fathom edge, and laying them down on a chart on a scale of about six inches to a nautic mile.

As upon such short notice it is probable you may not be able to obtain an extended scheme of points over this district from the Board of Ordnance, it will be sufficient for the purpose of the Commission if you take the points from the last published Ordnance survey, or, for want of a better, from that of Mackenzie, of 1787, marking in it any material changes in the coast line which may have taken place.

The material objects in thus employing Her Majesty's ship under your command may be stated as follows, viz.—

1. To enable you to ascertain, with the utmost accuracy, any change which may have taken place in the depth of water since the publication of the last Admiralty chart, or any charts of known good authority; and to mark in the chart you will deliver to the Commissioners the former and the present lines of any shoals, specifying the dates of those charts with which these comparisons may be made.

2. To observe the set and strength of the tide along shore from the Bill of Portland to White Cliff and Lulworth, both in the bay and in the offing; and to observe yourself and gain all the information you can from pilots and sea-faring men, as to the effect of the small river Wey, or any other stream that is likely to cause a deposit in the bay.

3. To describe the quality of the bottom carefully through both anchorages; also to note the movement of the shingle along the shore, and if what is brought in by the wind from one quarter appears to be carried off to sea, or carried back by any change of wind.

4. To anchor your ship on the six fathoms line at low-water springs, and when in that position to state the distance from the shore, and the bearings of the most prominent points and headlands.

5. To ascertain, by very careful sounding, any change the bottom may have along the six fathom line, that an opinion may be formed whether it has a convenient flatness, or otherwise, for the reception of long caissons in forming a breakwater, should such an erection be proposed.

6. To collect any information bearing in any way upon the objects pointed out to your attention, and to make such observations, respecting Portland and Weymouth Roads, as may enable you to answer any questions which may be put to you by the Commission.

You will occupy yourself in this business until the arrival of the Commission in Weymouth Roads.

I am, Sir,
Your obedient servant,
(Signed) T. BYAM MARTIN.

To Commander Sheringham,
Her Majesty's Ship, Fearless.

REPORT OF COMMANDER SHERINGHAM.

Report of Com. *Sheringham.*

Her Majesty's Steam Surveying Vessel, Fearless,
Weymouth, 26th May, 1844.

SIR,

I HAVE the honour to acquaint you that I have, in compliance with your directions on the part of the Harbour Commissioners, completed, with all the detail that the time would admit of, a survey of Portland and Weymouth Roads, on a scale of six inches to the nautic mile.

In order to insure the utmost accuracy in this examination, it was scarcely advisable to trust to an enlarged scale of Mackenzie's survey, and I therefore constructed a scheme of points on my own triangulation.

As the time would not permit me to lay down the whole of the coast line from my own observations, I have supplied the deficiency from the above authority, and have great pleasure in bearing testimony to that accomplished surveyor's general accuracy.

The Commissioners having drawn my attention to the necessity of marking any changes which have taken place in the depth of water since the publication of the last Admiralty survey, I have, in compliance therewith, carefully compared the two, and was much gratified to find, that with very few

Appendix A.

Report of Com. *Sheringham.*

exceptions, an extraordinary agreement existed; and for the satisfaction of the Commissioners I have here and there introduced upon my plan, in red, the depths transferred from the old survey.

It is to be regretted that the adverse state of the weather during the only period of spring tides that I have been here would not permit me to make those elaborate observations on their set and velocity which it would have been desirable to have done. I have not failed, however, to make diligent inquiries upon this important head, and verified the information thus obtained by personal observation at every opportunity.

I find, by actual observation, that the vertical rise of the tide at Weymouth Pier is inconsiderable, our register showing only five feet seven inches at springs, and three feet at neaps; it must be observed, however, that the late prevalence of strong north-easterly winds have considerably assisted in cutting the tides during the last lunation, but I am fully assured that seven feet may be considered as a fair spring rise.

With respect to the set of the tidal stream, it would appear that the main or Channel ebb, after passing St. Alban's Head, runs in a line parallel to the shore, until within a short distance of Whitenore Point, from whence it bends rather abruptly towards the Shambles.

To the northward of Whitenore, the ebb feeds further into the bay, but passes out again round Grove Point; and thus, as the head of the bay is approached, does the ebb form a succession of curves, taking the shape of the bay, gradually merging into each other, between North End and Grove Point, with accumulating velocity; until, at the latter position, it becomes, at springs, a perfect race.

The tide from Weymouth Harbour, when free from the influence of the piers, bends to the westward, takes the round of Portland Bay, and ultimately runs along the east shore of Portland, as before.

The main flood is deflected by the Shambles, and sets towards St. Alban's Head; but there is a considerable portion of it which runs within that shoal, and sets smartly round Grove Point, bending into the bay, and then across to Whitenore Point.

To the northward of Fern Hill, its velocity is very inconsiderable; indeed, within a line drawn from North End to Mill Cove, on the north-east shore, it has been well expressed by Mackenzie, that the tides are scarcely sensible. The set of the tides, when obtained by our own observations, have been inserted upon the plan, the red indicating an ebb, and blue the flood.

I have every reason to believe, from a close examination of the nature of the bottom at the entrance of the little river Wey, that no deposit takes place; and, from the remarkable clearness of the water in the roads, nothing of importance is carried out, although the line of the tide is distinctly to be traced by a slight discolouration indicating that some substance is held in suspension on a reflux tide.

It is at all times difficult to convey an accurate description of the bottom by what is brought up by the ordinary arming of the lead; but, as I am desirous that the Commissioners should be able to form as correct an opinion on that head as possible, I have deemed it expedient to preserve specimens of the surface for their inspection. I have reason to believe, however, not only from report, but from what has been brought up on our anchors, that the sand and gravel is merely a thin covering to a stiff blue clay, a specimen of which is also preserved.

Under this head I may observe that the general character of the bottom is perfectly clean or free from rock.

With respect to the travelling of the shingle, I have not been able to gain any very certain and satisfactory information. Doubtless, however, considerable quantities are occasionally thrown in by southerly gales. The principal deposit seems to be near the junction of the rising ground on the north-east shore with the low flat at the east end of the esplanade.

With the exception of that extraordinary ridge, the Chesil Beach, I see no deposit of consequence in any other part of either bays.

Agreeably with your directions, I anchored the ship on the six-fathom edge, selecting what I considered the most eligible part of it, and from thence took bearings of the principal head-lands, as follows; viz.—

Whitenore Point	East.
St. Alban's Head	South-east by east, half east.
Grove Point	South, quarter west.

Distant from the nearest shore two-thirds of a mile.

As an opinion prevails that, from the declivity of the bank, ships are very apt to drive in north-west gales, I have calculated the slope from the four to the thirteen-fathom edge, in about a north-north-west and south-south-east direction, which direction would probably cross the line of a breakwater at nearly right angles. The descent averages about three feet in a thousand. A section of the above slope is introduced upon the plan.

A quarter of a mile south of North End, or about midway between King's Pier and the Point, a line run out in a north-east a quarter north direction, seems to lead over a convenient flatness for the site of a breakwater, should such a proposition be entertained. For the first quarter of a mile the dip is very sudden, falling as it does, at that distance from the shore, into eight fathoms; but, from thence to the outer end, there are very few feet variation.

In conclusion, having, I trust, directed my attention to the several heads contained in your instructions, and informed myself on the subject as well as so short a time would allow me, I would request the indulgence of the Commission for not laying before them a more finished drawing, not having had an opportunity to make a copy of my working rough.

I have the honour to be, Sir,
Your most obedient servant,
W. L. Sheringham, *Commander.*

Sir T. Byam Martin, G.C.B.,
&c. &c. &c.

Report of Lt.-Col. *Jones*, R.E.

REPORT OF LIEUT.-COLONEL HARRY JONES, R.E., ON THE BEST SLOPES FOR BREAKWATERS.

Shannon Commission, Custom-House, Dublin,
June 1, 1844.

Sir,

The principle which generally has been adopted of employing long sea slopes for breakwaters in deep water having for some years occupied my attention, I beg leave to bring under the Com-

missioners' notice, in a condensed form, the substance of a communication which I made some years past to the Institution of Civil Engineers; the importance of the subject in an economical point of view, will, I am confident, ensure for it that consideration which it deserves.

As one of the Commissioners for the improvement of the navigation of the river Shannon, my attention was directed to the best form to be given to the extension of Kilrush Pier, near the mouth of the river, and exposed to the direct action of the sea rolling in from the the Atlantic in westerly gales, and calculating the time and expense to build the pier with a sea slope, as the Commissioners considered best in the first instance; and having had the advantage, before the work was commenced, of witnessing the effects of several severe storms upon Kingstown, Howth, and Dunmore harbours, each constructed with a long sea slope, having different angles of inclination, where all of these works suffered considerably from the effects of the sea breaking upon the long sea slope between high and low-water mark; the circumstances above mentioned, coupled with the previous knowledge of what had occurred at Cherbourg and Plymouth, induced me to pay more particular attention to the subject. I then visited Cherbourg, Granville, St. Malo, and other ports; at all these I found the upright section had been adopted, at the former the upright wall was building upon the *pierre perdue* in the form as shown on the tracing which accompanies this letter, marked A. About this period I had the advantage of making acquaintance with an American engineer, and who, when conversing upon the subject of the breakwater in Delaware Bay, informed me that in the United States they did not approve of the long slope.

I therefore strongly recommended to my brother Commissioners to alter the section for Kilrush from the long slope to the upright wall; this they consented to do, and the work has been executed according to the section marked B, coloured red. The section coloured yellow is the section as originally proposed.

The Commissioners will, at a glance, perceive the great saving as regards material, and consequently great economy in the time of the construction of the pier which has long since been completed, and which could not have been effected with the long slope in the same period.

I have not entered into the details of construction, because they must vary according to localities and materials to be used; at the same time I wish the Commissioners distinctly to understand that the principle I advocate is to present as *perpendicular* a face as possible to the action of the sea; and if expense was not a consideration, an upright wall founded on the bottom of the sea would, in my opinion, be the most desirable and preferable mode of construction.

The accompanying drawings show the sections of Cherbourg, Kingstown, and Kilrush; the first is accompanied with some written details of the construction of the new breakwater, and which appears to answer perfectly. There cannot be a doubt but that if the French engineers, with their present experience, had to construct another breakwater with *pierre perdue*, they would not form such a long foreshore; there is no necessity for it, as by observation it is ascertained that below the line of low water no disturbance takes place, therefore the more perpendicular it is built, the less cost in labour and materials.

A.

B.

C.

Kingstown still remains as insecure as heretofore; the enormous mass of stone placed on the outward slope at the line of low water is greatly acted upon with almost every easterly gale, and certain portions of the loading are washed away; even with the long slope which this pier possesses; the waves, in very heavy gales of wind, run over the apex, and, falling down, have repeatedly disturbed the surface of the roadway on the inner side. It is very interesting to watch the action of the sea upon the recently finished circular head of the eastern arm, and at the same time upon the long slope, where the two descriptions of work unite; against the former the sea rises and falls without violence; whereas on the long slope the sea breaks and falls upon it with great fury. Take the section of Plymouth, Kingstown, or Cherbourg, and ask any engineer if he considers such a mass of material, if properly disposed, necessary to resist the action of the sea, and he must, I conceive, say no. The great consumption of time, labour, and materials at Plymouth breakwater has been principally caused by the great base which was originally marked by buoys, within which the stone vessels were to discharge their cargoes; had the construction of the work been with a view of making the sea face as nearly vertical as possible, what a difference there would have been in the progress of the work, and in the amount expended! The angle which stones form when wheeled out from a quarry, or forming the head of an embankment, will be about 60° or 70°; and such, it may be presumed, would be the same with stones dropped into the sea with the intention of taking as perpendicular a form as the nature of the material will permit. Acting upon a narrow base, the mass would soon attain the height of low water, and this once accomplished, there would immediately be found quiet water on its inner side. The French at Algiers re-constructed the Mole with an upright wall, formed with blocks of beton in 30 feet water, which has stood remarkably well. The numerous examples of upright sea walls clearly demonstrate that they do and will resist the violent action of the sea if properly built.

In the Report of Mr. William Stuart, addressed to Rear-Admiral Warren, dated 27th February, 1838, it is stated, "The quantity of rough stones which have been thrown over from the foreshore to the northside along the *whole line of the finished work* amount to about 9,000 *tons!*

The more perpendicular the face of the work, the greater weight has a wave to lift, consequently the work is so much the stronger; in fact, against an upright wall the wave never breaks, provided there is deep water in front of it; in the case of seven fathoms, it may be presumed that, with such a depth, the waves would only rise and fall against the upright face.

The section, as proposed by me, is represented on a section of Kingstown Harbour, the *pierre perdue* of the outward face is drawn at an angle of 50°, (if it could be formed more perpendicular, so much the better,) the upright wall is to be founded as much below low water as possible; and this, in fine weather, can easily be effected at 2 feet 6 inches or 3 feet below that line; the *pierre perdue*, on the inner side, is laid down at an angle of 60°; at the same time it would be desirable to build a considerable portion of the inner face perpendicular with a diving-bell, so as to form a quay or wharf where line-of-battle ships could lie alongside, take in stores, &c. The advantages to be derived from such accommodation must be apparent to all professional men.

D.

In forming the base with *pierre perdue*, I would frequently throw in amongst the rubble, mortar made with hydraulic lime, this would cement the work into considerable masses, and thus form a solid compact body, which is particularly desirable.

In forming the lower portion with *pierre perdue* the operation should be confined to as narrow a base as possible, in order that the mass may raise its head as soon as possible above low water; this

Appendix A.

Report of Lt.-Col. *Jones*, R.E.

once effected, protection is obtained for vessels riding inside, and if a gale should disturb or wash down some of the work, it only disturbs a portion, and throws the material into a favourable position as regards the future progress of the work: compare the short period within which this can be performed with the length of time required to raise the mass upon the more extended base of a breakwater formed with a long sea slope above the level of low water, as at Plymouth or Kingstown.

Sections of Kilrush Pier are given, which show what was originally proposed, and what has been executed. The Commissioners have reason to congratulate themselves upon the change, as it would not have been possible to have attained within the same period the same extent of work and protection. The section, as executed, is greater than the old work, which, however, stood remarkably well. In forming the foundation, the work was performed by the diving-bell, with large flat-bedded stone set on edge; this description of work is quickly performed; and if there happens to be a soft spot, a few of them may sink a little by their own weight, and the superincumbent mass will not be affected by it, as the ashlar work may be regarded as resting upon as many points as there are stones on edge under it.

Should the Commissioners be desirous of having any further details, it will afford me great pleasure in attending to their wishes.

I have the honour to be, Sir,
Your obedient servant,
HARRY D. JONES,
Lieut.-Colonel Royal Engineers.

To the Secretary,
Commission for Harbours of Refuge.

Report of Mr. *Stuart.*

REPORT OF MR. STUART ON PLYMOUTH BREAKWATER.

(Referred to in the preceding letter.)

SIR, *Plymouth, February* 27, 1838.

AFTER you left me at the breakwater yesterday morning, I waited until low water, when I was enabled to take a full survey, and take measurements of the damages done to the breakwater by the heavy seas and high tides of Saturday night and Sunday morning last, and therefore now beg leave to give you a detailed report of them.

The quantity of rough stones which have been thrown over from the foreshore to the north side, along the whole line of the finished work, amounts to about 9000 tons, of which there are about 1000 tons only in the whole length of the finished work, to within 250 feet of the foundation of the lighthouse, and in that space the remaining quantity of about 8000 tons is now lying; the reason of so much being thrown over at that place is, from its lying directly inside the Nap and Panther shoals, on which the sea constantly rises to a very great height, and comes unbroken directly on that part of the breakwater; indeed it is these seas which always cause so much damage in the Sound. The stone, some of them from seven to nine tons in weight, coming in constant succession, and with such tremendous force in contact with the masonry (at that part where the toe of the south slope is unfinished), broke and loosened it; and the sea having once obtained an entrance, about 23 yards in length and five yards up the slope have been swept away, and about 33 yards shaken. There has been a settlement of the work for about 100 feet in length, where the work is only cased with dressed stone, and a few stones in the middle of the south slope have been thrown out, which I attribute to the air getting between the interstices in the rubble work, being violently compressed by the lift of the sea, and thereby forcing them out. I am happy to state that no part of the solid masonry around the foundation of the lighthouse has been injured, not even a joint opened, as far as can be seen. The injury at the east end is so trifling that it is not worth mentioning, the south slope having only settled down a little.

As far as my own observation goes, and which is confirmed by the opinion of others, the sea was much heavier than during the gale of 1824; and as a proof of it, the stones placed upon the top of the work at the east end for the protection of the jetty, and which have been there for twelve years bedded in cement, and bound down with iron cramps, have been torn up and thrown over on the north side of the work; and also the masonry at the west end built for a similar purpose, has been completely swept away.

I shall without delay proceed to erect a crane to replace the stones, and commence throwing very large stones in front of the foreshore, where the breach has been made, and which, in my opinion must be our chief protection at that part of the work.

I am, Sir,
Your obedient servant,
WILLIAM STUART.

To Rear-Admiral Warren.

Report of Capt. *Washington.*

REPORT OF CAPTAIN WASHINGTON ON THE MEMORIAL OF THE MAYOR AND CORPORATION OF THE BOROUGH OF HARWICH.

Woolwich, January 19, 1843.

THE port of Harwich, owing to its general depth of water, its extent, the shelter it affords, and immediate communication with the sea, is one of the most valuable on our eastern shores; and although the rivers Thames and Humber afford shelter by running far up them, yet Harwich, from its easy access by night or by day, in all weathers, and in all states of the tide, is the only harbour of refuge, properly so called, on the East coast of England.

Memorial of mayor.

The memorial of the Mayor and other inhabitants of the borough of Harwich states, that in this harbour, which in easterly gales has given shelter to 500 sail of shipping at once, great changes have taken place within the last 20 years, owing to the falling down and washing away of Beacon Cliff on the western side of the entrance, and the growing out of Landguard Point on the eastern side, whereby the harbour is already much deteriorated, and is daily becoming worse.

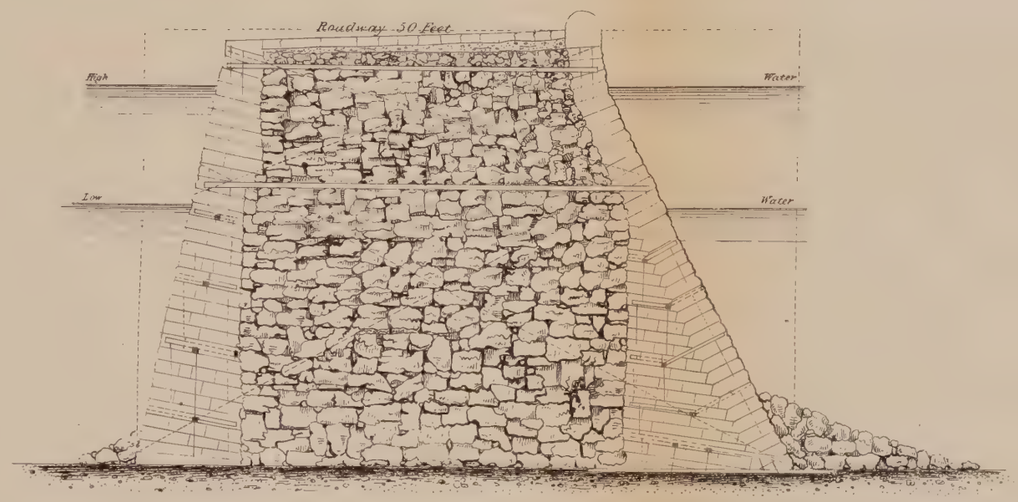
To the truth of this statement I can bear the fullest testimony from my own observations during the last two years, and all the evidence I can obtain, goes to show that the sole and immediate cause of the damage in question is, the digging up and carrying away the cement stone from the foot of Beacon Cliff, and Felixstow Ledge.

To face page 134 in Evidence.

PROPOSAL FOR BUILDING HARBOURS OF REFUGE.

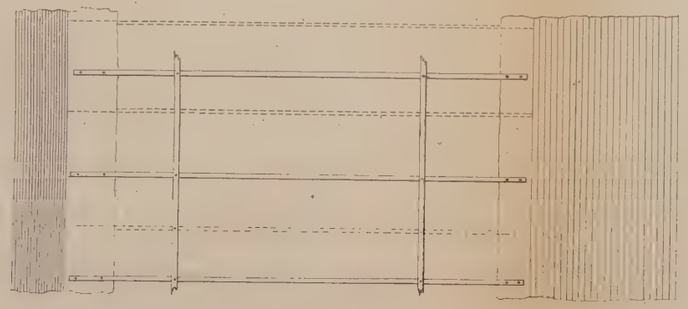
REFERRED TO IN A REPORT BY JAMES BREMNER 1844.

SECTION OF PROPOSED PIER.

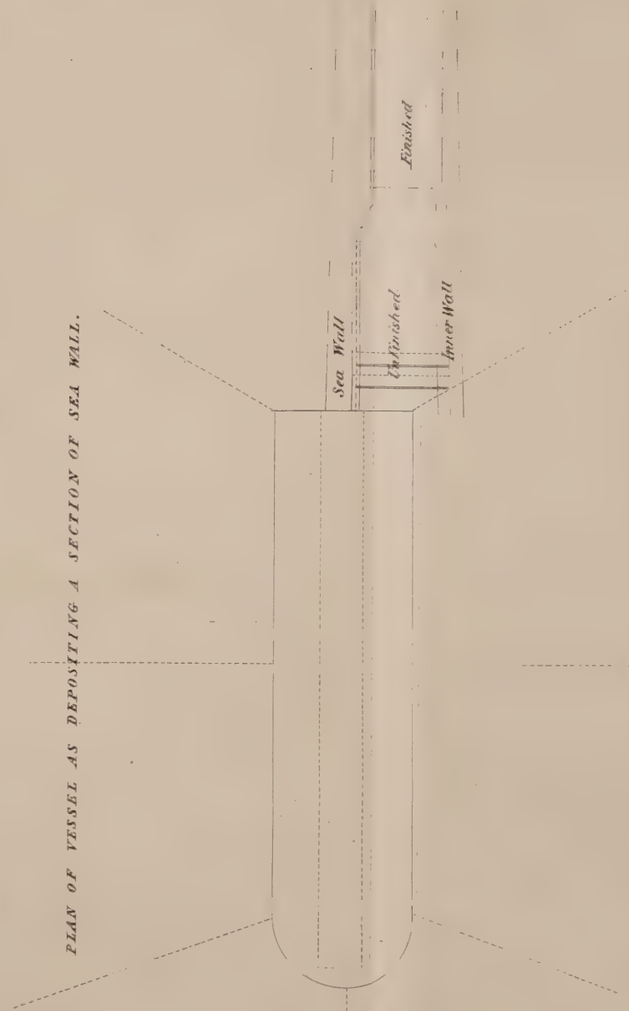


Horizontal section of a wall shewing mode of binding by Timbers

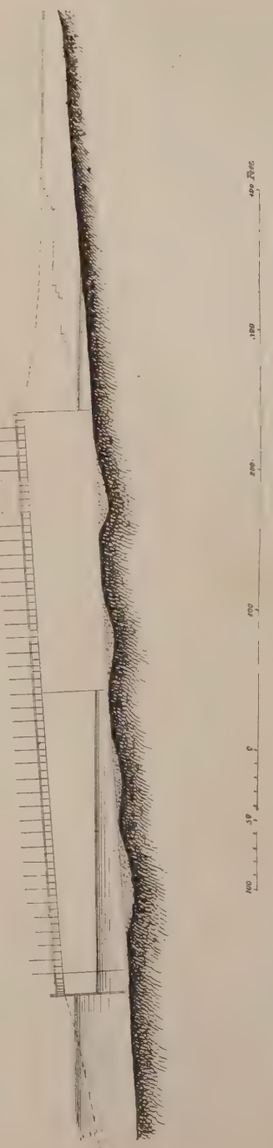
Horizontal section of Walls shewing mode of Tying.



PLAN OF VESSEL AS DEPOSITING A SECTION OF SEA WALL.



Section shewing Vessel laying section of Wall on Sloping bottom originally uneven, made straight as described.



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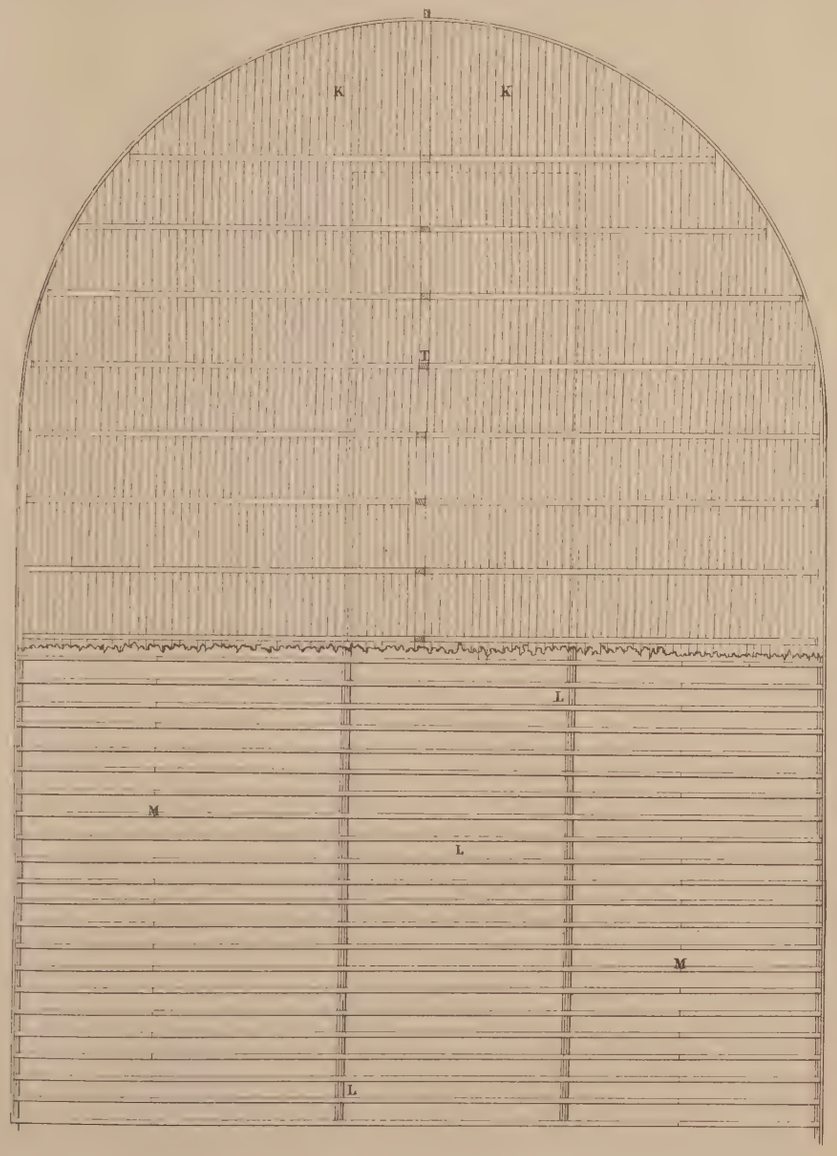
To face page 153 in Evidence

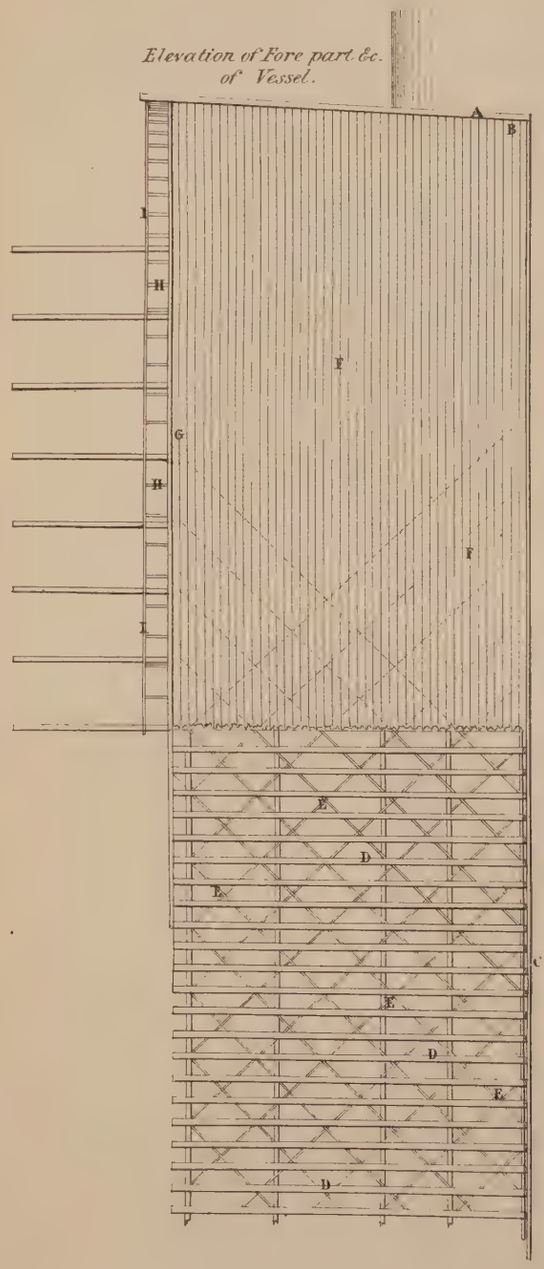
PROPOSAL FOR BUILDING HARBOURS OF REFUGE.

REFERRED TO IN A REPORT BY JAMES BREMNER 1844.

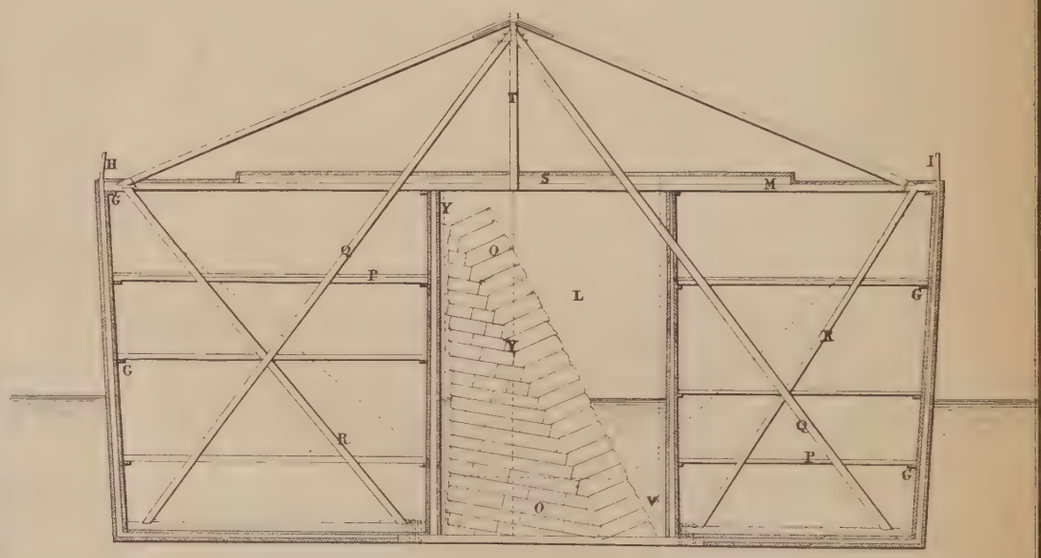
Plan shewing portion of Fore part trussed beams, deck beams compartments &c of Vessel.



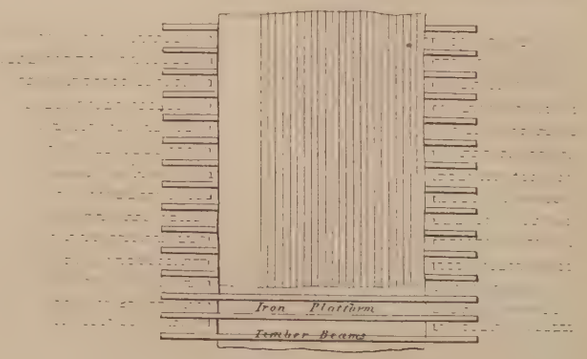
Elevation of Fore part &c. of Vessel.



Transverse Section of Vessel Sea wall, &c. afloat.



Plan of Sea wall, Ship bottom, and position of Vessels Floors.



10 5 0 10 20 30 40 50 60 70 80 90 100 Feet

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Report of Capt. *Washington*.

From the unanimous testimony of the older inhabitants of Harwich, it appears that Beacon Cliff (which is entirely composed of Blue or London clay, with layers of *Septaria* or Cement stone), has fallen away much more rapidly within the last 25 years than it did at any previous time; but not feeling quite satisfied with this evidence, I have procured plans of the town and cliff for the years 1709, 1756, and 1804, and have transferred the high and low water lines for these several periods to the plan of Harwich, completed last year in Her Majesty's ship *Shearwater*. From which it appears that in the first half century less than 40 feet, or not a foot a year, of the cliff was washed away; in the second half century about 80 feet went to sea; while during the last 37 years the sea has advanced in a direct line upon the land not less than 350 feet; and the beach at the foot of the cliff has been so much lowered that the low water line, during this short period, has gained 600 feet upon the shore; thus presenting on the western side a greater surface of water, whereby the scouring effect of the flood and ebb streams in keeping the channel clear is much weakened; a barrier that tended to shoot the ebb tide over against Landguard Point is removed; full 40 acres of ordnance, glebe, and manor lands, of excellent pasturage, with tenements and other property, have been swept away, and the harbour deprived of an invaluable breakwater in southerly and south-westerly gales.

Loss of Beacon Cliff.

Evidence from old plans.

Now, the traffic in cement stone began about the year 1812, or 30 years ago, since which period, I am credibly informed, that upwards of a million of tons of this stone have been carried away from the shores in question. This fact, combined with the evidence derived from the plans, seems conclusive as to the cause of the encroachments of the sea upon Beacon Cliff.

Traffic in cement stone.

But while the sea has gained upon the land on the western side of the harbour, the contrary has taken place on the eastern or Suffolk side, where within the last 30 years Landguard Point has grown out 1,500 feet, thereby blocking up the chief entrance into the harbour; so that where in the year 1804 was a channel seven fathoms deep at low water, is now a shingle beach as many feet above high-water mark.

Extension of Landguard Point.

This mischief has been accelerated by carrying away the cement stone from the foot of Felixstow Cliff, about two and a half miles to the north-eastward, where it formed a rocky projecting ledge which served as a breakwater, for the whole of this shore, from the force of the sea in north-easterly gales. But since this stone has been removed (to an extent of 200,000 tons I am told), a large slice from Felixstow Cliff has gone into the sea, two mortella towers and a small battery, only built in 1808, have been swept away, and the beach at Landguard Point has grown out, as above stated, to the extent of 500 yards, in consequence of which the two lighthouses, erected but a few years since at a great expense, are no longer a safe leading mark into the harbour; on the contrary, they have already caused serious damage to several vessels by running them ashore.

Felixstow Ledge.

These are great and increasing evils, and demand immediate attention, if the port of Harwich is to be preserved.

It is the province of an engineer to point out the proper remedy to take, but the more obvious measure would seem to be to put an immediate stop to the daily practice of carrying away cement stone from the foot of the cliffs, and to replace by an inexpensive breakwater of rough stone run out about 800 yards, the natural barrier which has been carried away from the foot of Beacon Cliff, whereby the ebb stream will be again directed against Landguard Point, so as to prevent its extension, and the shelter to the outer part of the harbour in northerly and southerly gales will be restored.

Remedy recommended.

Of the large quantity of cement stone that has been carried away from under Beacon Cliff, I am informed that 200,000 tons have been taken by the Board of Ordnance, and applied to Government uses.* If such is the case, perhaps it might not be considered as expecting too much to call upon that Board to protect the cliff from further encroachments, and to replace by groynes, or other artificial means, the natural breakwater that they have been instrumental in causing to crumble into the sea, and thereby most seriously damaging the harbour.

Mr. Walker and Mr. Rendel have recommended a pile jetty along the northern face of the town, in which I fully agree; but the interests of navigation require that some care should be bestowed in preserving and improving the present channel intothe harbour. Since the deep water entrance by Landguard Point is lost (certainly for some time to come,) the actual channels should be dredged so as to command a depth of 15 feet at low water, or 27 feet at high-water springs; this would be attended with little expense, as the dredgers now on the spot would gladly undertake the work for a bounty of 1*s.* a ton on all the cement stone taken away from the different shoals in the harbour, and there would be no difficulty in pointing where and how this might be done to the greatest advantage.†

A pile jetty recommended.

Dredging proposed.

A small red harbour light would also be required to be placed about 25 yards to the southward of the present low light, to obviate the mischief now of daily occurrence, in consequence of the two lights in one being no longer a safe leading mark to clear Landguard Point. The harbour buoys might also be much more advantageously placed than at present,‡ and two or three small beacons would be required; but the greatest improvement to the navigation of this part of the coast would be a small floating light near the entrance of the harbour, and a fixed light at the tower of Walton-on-the-Naze.

Improvements in surveying.

The above recommendations are suggested not only by the increasing trade of the ports of Ipswich and Manningtree, of which Harwich is the outlet, and by the extent of the Government property in the town, but more especially by the present value of this harbour as affording shelter to the vast body of shipping that daily pass along the east coast of England in winter as well as summer, and the facility with which assistance is rendered from this port to vessels wrecked on the Shipwash to the north-east, and the West Rocks, and Gunfleet Sand to the south-east, perhaps the most dangerous sands in these seas. It is well to bear in mind what this port was during the last war, and what it must again become for another North Sea fleet. It was from Harwich that the Hollesley Bay fleet was always watered by transports; it was here that all vessels, from a frigate downwards in case of need came for a partial refit at the naval yard still in existence; here not less than 60 ships of war have been built, 15 of which were two-deckers, while the tonnage of the vessels employed in the North Sea Fishery belonging to Harwich, a few years since, was estimated at 3000 tons, employing 500 hardy seamen.

Increasing trade.

Holles'ey Bay, fleet watered here.

North Sea Fishery

These considerations alone would more than justify any small outlay to preserve this port from

Probable mail station.

* The Ordnance have had a cement mill at Harwich, since the year 1818, let the greater part of the time for 500*l.* a year; and now at 300*l.* a year.

† The Admiralty have since granted 100*l.* for this purpose, besides which the Corporation of the borough of Harwich have liberally expended a similar sum, with which 530 tons of soil were dredged up; 70 tons of this were of cement stone, worth 5*s.* a ton.

‡ These alterations have since been made by the Trinity Board, with the invaluable addition of a light vessel placed near the entrance of the harbour.

To face page 16 — Appendix A.

DOVER BAY,

IN APRIL 1844.

Surveyed in H M.S. Blazer.

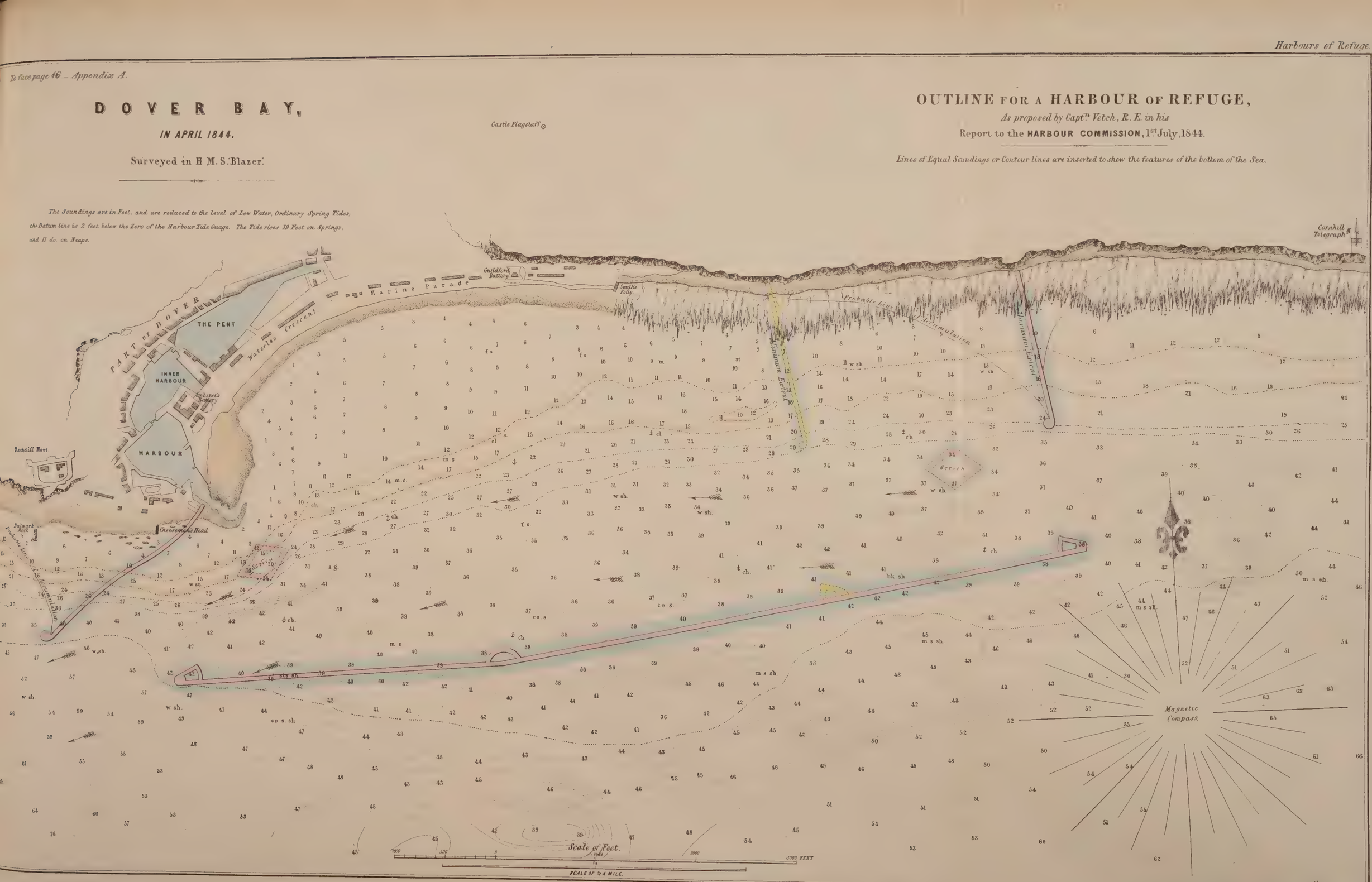
The Soundings are in Feet, and are reduced to the level of Low Water, Ordinary Spring Tides; the Datum line is 2 feet below the Zero of the Harbour Tide Guage. The Tide rises 19 Feet on Springs, and 11 do. on Neaps.

OUTLINE FOR A HARBOUR OF REFUGE,

As proposed by Capt.n Vetch, R.E. in his

Report to the HARBOUR COMMISSION, 1st July, 1844.

Lines of Equal Soundings or Contour lines are inserted to shew the features of the bottom of the Sea.



Standidge & Co Litho London.

If the entrances at both ends, or at one, were stopped, and others opened in the south front, the consequence would be, that as the tide flowed a current would pass into the harbour through the front entrances at right angles to the current outside, and carry with it a quantity of the material from the tongue or shoal alluded to, and deposit the same in the tranquil parts of the interior, as during the rise of the tide the only current in such a case would be inwardly, and though active at the point of entrance, it would speedily disperse and diminish, and permit of the deposit of the matter held in suspension at no great distance from the entrance, where it would remain; for on the ebb tide, though the current would only be outwardly, it would have little activity except near the openings; and though it could not materially remove the depositions from any great distance inside, it would scoop out a deep channel near the entrance, and in its conflict in meeting the outside current at right angles, a bank or bar would probably take place.

By having only two entrances, one at either end, in the direct line of the natural currents, we obtain a scour completely through the harbour, so that whatever material might be brought in through one entrance, would in all probability pass out by the other; and as a constant and thorough current and agitation would be kept up through the whole length of the harbour, the fine matter held in suspension would continue so until ejected at the opposite end. It may be considered a convenient arrangement besides the entrances at either end, to have a third for the passage of vessels in the middle of the south front. But that convenience would be dearly bought by the risks to which such an entrance would expose the harbour; as at certain times of the tide and wind, a cross or oblique current would be introduced to disturb the interior one, and when once a direct current is interfered with under such circumstances, it is difficult to foresee how much mischief may be done by the formation of banks.

I am therefore distinctly of opinion that if a harbour of refuge is constructed off Dover, it and should have two entrances, one at either end, in the direct line of the tides, and none on the south front; and though this may not be considered the most convenient arrangement for shipping, it must be considered as a necessary evil to avoid others of a more important and dangerous nature.

I have endeavoured to conduct the south front in as straight a line as other contingencies will permit of. If the southern or long front presented a convex form outwardly, such a disposition would give more capacity inside in proportion to the extent of pier used; but the corresponding concavity inside would present shelter for depositions to take place on; indeed whatever outline of pier be adopted for the south front, I am led to expect there will be a tendency to deposit on one or other, or both sides of it; but if the form be curved the deposition will form more extensively on the concave side, while the convex side would remain comparatively clear. But if we were to make the south front convex inwards, though that would tend to keep the anchorage clean, it would contract the area of the harbour and render the anchorage more exposed; and I therefore consider the straight line (or a form closely approaching it) as the most prudent and suitable, and what I have adopted in reference to other considerations is a front to the south composed of two straight lines meeting at an angle of 172°. The west branch is 1100 yards long, and its prolongation is directed (considerably within the line of Dungeness) upon Romney-mill nearly, and verging to the shore at Folkstone. The eastern branch of the south front is 1970 yards long, and is directed upon the South Calliper, and verging to the shore at the South Foreland, so that the end of each branch is well protected in its landward prolongation, and in their seaward prolongation they mutually protect each other; and these circumstances have induced me to diverge from the absolutely straight line to a small extent. The proposed south front faces the nearest part of the French coast, and therefore there can be no long fetch of the sea directly against it, and what there is must be much mitigated by tide currents crossing it.

The south front is doubtless the great and important feature of the harbour of refuge, and the weakest and most assailable from its extent and more exposed position; but it is fortunate it is not exposed to any formidable *direct* assault, the wind that would prove most injurious if exposed directly to it, would be near the south-west (by compass), or that coming in between the Varne Bank and Dungeness, but a sea rolling in for that quarter would meet the south face very obliquely; and the line on which the south front could be most directly and powerfully assailed is in some degree protected by the Varne and Ridge banks, and still offers an obliquity of 30° to the line of action upon it. Though the coast of Dover is much exposed, I consider the line of south front now proposed as the most favourably disposed to meet all adverse circumstances; but in fixing upon the line shown in the plan, I have not been inattentive to the form of the bottom of the sea where it is placed. With the same direction and form, the south front, might have been advanced more seaward, or retired more landward; and I have been induced to adopt its identical parallel position, to base it on a ridge or swell of the ground which extends in the required direction, and which encloses deeper water at either extremity than does the site of the pier itself; and though a difference of three or four feet of depth may appear of little consequence in the choice of a foundation, still it is important rather to place it on a swell of the ground, which indicates a slackness of current than in a hollow or channel which indicates a quickness of current.

Western Entrance.—The west pier head is formed on a rising portion of the bottom or low sand bank, which leaves a deeper channel inside, and the 40, 42, and 46 lines of soundings show that this pier-head is placed at a point where the main current bifurcates or diverges, one branch setting into the Bay of Dover, and the line of this diversion or separation of the stream is also that chosen for the line of the south front. On considering the qualities required for the west entrance, we have first, to attend to a free passage to the inset of the tide; second, to endeavour to exclude the shingle; third, to give the harbour inside as much shelter as circumstances will permit; and fourth, to throw such a current across the mouth of the present tide harbour as would clear away all accumulation in front of it, and give a clear entrance in future to that otherwise very excellent tide harbour.

To exclude the shingle, and to give the greatest shelter inside, it is necessary to run out a solid pier from the shore to the greatest extent consistent with a free entrance to the current; and that the current may freely pass into and through the harbour without eddies and deposits, it is necessary that this solid pier should point obliquely to the entering current; and I have designed a solid pier, commencing at the south pier-head of the present tide harbour, passing obliquely in front of Cheesman's Head, and terminating opposite the Bull Rock in 42 feet water, and at a distance of 383 yards from the shore, and formed on a line of double curvature, concave near the entrance to receive and direct the entering current, and convex towards the shore to give it the stream a clear passage across the mouth of the present tide harbour.

Against the pressure of shingle on the west side, this pier will present a slightly convex outline;

and if in process of time the angular space outside should completely fill up with shingle, as most probably it would, it will then become necessary, from the head of the proposed pier to run a branch somewhat parallel with the shore, and two or three yards of annual extension on this line would probably suffice to contain the shingle, or, if deemed more advisable, a second or third pier or groin may be thrown out from the shore more to the westward; but let the work be which it may, I should most distinctly propose to apply works to intercept the passage of the shingle as an essential condition of the scheme.

The present tide harbour is a most important matter for consideration, from its costly quays and docks and warehouses, and if in addition to the shelter afforded to the entrance by the refuge harbour, the shingle is intercepted and a current brought across the mouth, it will hereafter be quite accessible to all vessels for which the interior has a sufficient depth of water; but it will become more accessible under these altered circumstances, if about 120 feet is lopped from the North Pier-head, which would widen the mouth and make the entrance more direct, but the curtailment of the North Pier would also be necessary for the free flow of the current through the refuge harbour, and would prevent some eddies and tendencies to deposit near the mouth of the tide harbour.

I admit that the proposed western entrance would leave the anchorage somewhat more exposed than I could wish, but amidst so many difficulties, it is impossible to provide equally for the whole, and it becomes a matter of judgment to attain the most numerous and important benefits with some sacrifice in other points, but the evil of insufficient shelter at the western entrance, if it should prove of any consideration, may be counteracted by a screen or detached pier inside in the position marked on the plan, and which might otherwise become useful as a site for a battery.

Eastern Entrance.—The east end of the south front is 966 yards from the shore, and it will form the South Pier Head of the east entrance, which I propose to make 373 yards wide, the remaining portion of the distance being enclosed by a pier 547 yards long projecting from the shore, the prolongation of which forms an angle of about 89° with the east branch of the south front; this direction of the East Pier makes it form an angle of about 75° with the general line of shore outside, and an angle of 105° with the shore inside, and this disposition I have adopted from two considerations:—1st. That the east end of the south front may be more able to shelter and protect the entrance; and 2ndly, that the westerly set of current may the more effectually enter and be conducted through the harbour; in most of the projects for a harbour at Dover, a contrary plan is adopted, and the Eastern Pier forms an obtuse angle with the shore outside, but this must tend to deflect the westerly set of current to the outside the harbour, instead of through it, and if I have adopted any prevailing principle more than another, it is that of procuring a direct and thorough current through the harbour to prevent all deposition and tendency thereto.

By reference to the plan, it will be seen that the East Pier forms a deep and dead angle inside, which will naturally be tranquil, and where silt will deposit, and where the shingle already inside will accumulate, but the sooner that dead angle silts and shingles up the better, as the contour thereby given naturally to that portion of the harbour will tend much to improve the currents and channels elsewhere, and it will become a receptacle for all excrescences in the bottom likely to be removed; thus in the improvements at the west end, I expect the shingle lying at the mouth of the tide harbour will travel along the shore until intercepted by the East Pier, and this action may be more effective, if besides lopping off 120 feet from the North Pier Head of the tide harbour, as already mentioned, we also cut off as much of the Castle Jetty, (or Smith's Folly, as it is sometimes called,) as might be safely attempted in respect to the buildings on the line of shore. When the corner formed inside by the East Pier is once filled, all farther travelling matter would pass through the east entrance by the increased power of the current; indeed, if I did not expect that this nook would fill up, I should propose to make the East Pier still more oblique to the shore to give the issuing stream a more gradual convergency and more effective action outwards.

I have now concluded what is necessary to state in respect to the *linear form* of the proposed harbour and its entrances, and I have next to notice the materials and the form and mode of structure of piers most suitable to the locality.

From the reasons given in my Memoir on Breakwaters, (laid before the Admiralty last October and now referred to your Commission,) confirmed by practice and supported by theory, I should distinctly object, to all tumble stone breakwaters with long seaward slopes, and I should deem it most imprudent to recur to such a principle in spite of such dear bought experience, particularly at so exposed a site as that of Dover.

If we could choose the kind of sea-wall most desirable for a harbour of refuge, we would prefer a solid wall of granite masonry rising boldly and nearly perpendicularly out of deep water; but when we enter into the difficulties and expense of preparing foundations for them and carrying on such a structure on so exposed a coast, we soon perceive that the time and expenditure required would be so great as to render it impracticable on the usual mode of proceeding.

Some have proposed a combination of the tumble stone breakwater and a solid pier of masonry, that is, to form a foundation with tumble stones to low-water mark, and from this to carry up a solid wall nearly perpendicular, and this modification would no doubt be a great improvement on the old plan, as has been pointed out particularly by Colonel Harry Jones, because the most destructive action of the waves is between the high and low-water marks, while below the latter, the destructive action is comparatively feeble. Such a structure, in many places, might be very suitable, but it may be doubted whether it would be altogether appropriate on the coast off Dover. The objection which has been urged against this combined plan, is, that should the foundation of loose stones by any accident give way the solid pier must fall also; it appears also to me, that in respect to harbours with narrow entrances, that the system of tumble stones, whether carried up to high or low-water mark would much obstruct the entrances, for at openings with 42 feet of depth at low water, the bases of such structure would occupy 480 and 336 feet of the breadth of entrance respectively.

As preferable to either of the above plans, I should adopt the plan of a double row of iron caissons of a triangular section filled with concrete within and between, agreeably to the diagram I furnished the Commission, and suggested by the wooden caissons, proposed by Mr. Cubitt, as the core of a tumble stone breakwater; but at the same time, I think a fair field of competition is open between this mode and that of using upright rods of malleable iron in the manner pointed out in my memoirs on the subject already alluded to and printed in Weale's quarterly papers on engineering.

Against that plan, it has been urged, that malleable iron is subject to decay in the sea. I however do not admit that good iron is so perishable in sea-water as many allege, and we have lately had

Proposition for a Harbour at Dover.

several structures, as beacons and lighthouses, supported in salt water by iron rods. Yet, if I admit the validity of the objection to the fullest extent, my answer is, that my skeleton piers of iron, admit, with facility, of being made solid in a variety of ways and by a variety of materials, whenever through symptoms of decay or from any other cause the operation may be deemed requisite, but by filling up the structure solid as it progresses this objection has no room to exist.

And if I look at these piers of iron framings, merely in the light of a preliminary measure to other operations, I am of opinion, that a solid structure may be more expeditiously and more economically procured through means of such an auxiliary than by any other mode now in practice, and if I were required to carry out solid walls of granite off Dover, I would, as a preliminary measure, carry out in advance a pier of iron rods. If however a pier of iron rods is carried out on the skeleton form, it can be made, at little additional expense, capable of intercepting the undulations of the sea as effectually as granite itself; and it might be time enough to incur the additional expense of solidifying it, when the iron gave symptoms of decay. As to the precise mode of applying solidity to the structure so many methods have presented themselves, that I have not as yet been able to fix on the most eligible, but must leave that point open for farther consideration; as I have however in my evidence, alluded to the combination of the principle of iron rods with that of iron caissons, I shall here offer one illustration. Suppose a pier of iron rods to be carried out in a perpendicular form, for 100 yards in advance of the solid structure, I might place a half caisson on either side; that is to say, a caisson of the shape of those proposed, as divided in two by a plane passing longitudinally and vertically through the apex of the triangular prism.

These caissons would have one upright side placed against the side of the pier, the other side sloping outwardly at 30 degrees from the perpendicular. The iron rod pier would give every facility for accurately and conveniently placing these caissons in their position, and when there, the same facility would be offered for filling them with concrete, or brickwork, or masonry, &c., and as the double line of caissons advanced enclosing the pier, as many of the upright rods as might be deemed necessary might be drawn, and the interval filled with concrete, rubble-work, or other material.

With respect to the progress of the works, the end, or wing piers, could be proceeded with independently from the shore, and in regard to the south front, I do not apprehend any very great difficulty in establishing two or three starting points, and of progressing from these with one or two ends, and in that manner, I consider the work might be completed (at least in the skeleton form) in three years, if the materials were in timely preparation. I am however quite aware of the great accommodation of keeping up a continuous communication with the shore, and it might become a question whether it might not be most advisable to proceed from the two extremities of the harbour at the shore, and to work from two ends towards a centre, leaving the spaces about to become entrances in the open skeleton form of pier, and afterwards to remove the materials when the two ends nearly approached the centre.

Estimate of Expense.—This is about the most difficult problem to solve in respect to the proposed harbour considering the exposed situation off Dover with tides of 19 feet rise and fall, and with no aid from natural features or foundations and the extent of the necessary works; the cost of enclosing Dover Bay on any kind of structure must be very considerable, for allowing six feet for foundation and six feet above high-water mark, the height of the required piers would be 72 feet, and the extent of walling, though not all of that height, would amount to 4304 yards, the cost of which on the most economical plan, would not be less on the average than 300*l.* per yard, which would give a total of 1,291,200*l.*; I should however observe, that the harbour as now required and proposed, is considerably more extensive than that estimated for by the Government Commission in 1840, and of that subsequently estimated for by Mr. Cubitt.

I have the honour to be, Sir,
Your most obedient Servant,
JAMES VETCH.

Admiral Sir Byam Martin, G.C.B.,
Chairman of the Harbour Commission.

CAPTAIN WASHINGTON'S REPORT ON EASTBOURNE BAY, ON THE WATER IN DOVER BAY, AND ON THE NATURE OF THE BOTTOM OFF DUNGENESS.

Report of Capt. *Washington.*

Her Majesty's Ship, "Blazer," East Bourne Bay, June 25, 1844.

SIR,

IN compliance with your instructions of the 7th June, I have now the honour to lay before you a new survey of East Bourne and Pevensey Bays and the Royal Sovereign shoals, on the scale of four inches to a mile, nearly, which has been completed by Lieutenant Cudlip and Mr. E. K. Calver, Assistant Surveyors of Her Majesty's Ship "*Blazer*," during the past fortnight.

New survey.

The partial survey of the in-shore portion of the bay, by Captain Bullock and Mr. Burstall, R.N., for the use of the Harbour of Refuge Commission, of 1840, we have found, as far as it extended, to be perfectly correct; but on comparing our recent examination with those of 1809 and of 1826, published by the Admiralty, which are the latest and indeed the only charts extant, the chief alteration of feature appears to be, that a closer examination has brought to light more shoal patches, inasmuch, as by the former, only nine spots of less than 5 fathoms water appear, in the present, there are, I regret to say, as many as 21 detached shoals of that depth.

The remarkable projection of the Holywell Bank, beyond the pitch of Beachy Head, is now accounted for by the extension of the chalk ridge called Beachy Head Ledge, which we find to run out in a south direction above a quarter of a mile below low-water mark. This ledge, and Beachy Head itself, are the cause of the sand named the Holywell or Sand-acre, which is an extensive flat, having generally nine feet of water over it; towards its eastern end the fishermen call it the Boulder Bank, owing to some flint boulders found upon it. This bank is distinct from the Holywell Ridge which lies inside of it.

Holywell Bank.

Although, at first sight, this sand appears much in the way of shipping rounding Beachy Head to seek shelter in the bay, it does not seem to have been the cause of any wrecks of consequence, and it certainly is of benefit in preventing the weight of the sea from setting home on the beach, as we learn not only from the fishermen here, but also from our own experience, while lying in this bay during a strong south-west breeze.

The Sand-acre.

We found the holding-ground good wherever we anchored, and generally clay or soft chalk. On

Quality of holding ground.

one occasion, off Langley Point, our anchor brought up a large mass of pebbles or shingle, embedded in clay, resembling a soft plum-pudding stone, the only instance in which I ever remember finding shingle below the range of low-water mark.

Royal Sovereign shoal.

On the Royal Sovereign shoal, so called from a ship of that name having grounded in it in 1756, we had a cast of *ten feet* water only, and the lead brought up red clay of as bright a colour as red lead.

The tides were carefully watched during the survey by Lieutenant Conjuit, R.N., the officer of the coast guard on this station; and I have much pleasure in stating that here, as well as elsewhere along the coast, I found the greatest readiness on the part of the coast guard officers and men to forward the service in any way in their power.

Tides.

Spring tides rise 20 feet, and the neaps 13; and the stream of tide, both on flood and ebb, sets fairly through the bay at the rate of two knots at springs and one knot at neaps. The time of high water, contrary to our expectation and to all Channel sailing directions, is nearly half an hour later than at Dover.

I have little to add to my former report in April last on this bay, except to say, that a more detailed examination has entirely altered my preconceived opinions, and confirms me in the opinion I then felt myself obliged to express that, although Beachy Head affords fair natural shelter in the prevalent westerly gales, and although there is no part of the Channel in which a harbour is more desirable than in this vicinity, still it would hardly be prudent to hold out any inducement to lead vessels into East Bourne Bay, for it would be difficult to place a breakwater there in any position in which a ship would not risk getting into three-fathoms water in entering or leaving by its eastern opening, and thus encounter a heavy broken sea; or, yet worse, would risk getting entangled by the more dangerous rocky shoal of the Royal Sovereign or the Horse of Willingdon, in the very possible event of missing the port when running for it in a south-west gale and thick weather.

Difficulty in placing a breakwater.

DUNGENESS.

Dungeness.

On our return to the eastward, having the advantage of a tide-scale, well fixed at East Bourne, and another at Dover, we re-examined with much care the Swallow Bank, in Dungeness East Bay, and found it, as I before stated, to have decreased nearly half its whole size in extent, and that the depth of water has increased on it from 16 feet, as represented in former charts, to 22 feet at low-water springs.

Swallow Bank.

Quality and slope of bottom.

We also tried experiments, in compliance with your instructions, on the nature of the bottom off the pitch of Dungeness. This we did by means of a circular scraper, or iron bucket, with a sharp lip, attached to the palm of a small anchor, and having let it go at every two fathoms depth, from 3 out to 20 fathoms, we found that, with the exception of the first, which was shingle (at not half a ship's length from the beach) each time the anchor brought up mud, without the trace of a pebble. The slope of the bottom, from low-water mark seawards, as far as 16 fathoms, was found to be as follows:—

	Foot. Feet.		Foot. Feet.
To 2 fathoms	1 in 21	From 10 to 13 fathoms . .	1 in 9
From 2 to 4 fathoms . .	1 in 12	From 13 to 14 ,, . .	1 in 38
From 4 to 7 ,, . .	1 in 5	From 14 to 15 ,, . .	1 in 38
From 7 to 10 ,, (at 180		From 15 to 16 ,, (at 430	
yards from the beach) .	1 in 3	yards from the beach) .	1 in 40

then flat for a considerable distance to seaward. This is more distinctly shown in the plan.

No shingle below low-water mark.

On landing on the beach in East Bay, about three miles from the Ness, I found blue clay on the surface at about half way down to low-water mark, and the fishermen told me it was a common practice, when they wanted worm for bait, to shovel the shingle aside, when they soon came to the clay in which the worm lives.

The officer of the coast-guard at No. 2 battery, Lieutenant Coombe, R.N., had taken much trouble to dig down into the shingle on the beach above high-water mark but found it difficult, and had not succeeded in getting below six or seven feet. He stated, however, that his well was 15 feet deep and that the bottom of that was certainly clay.

Captain Peat, R.N., Inspecting Commander of the district, is of opinion, that the shingle is 20 feet deep, but I am not aware that he has been able to bore to that depth at any spot; nor has Captain Kerr, R. N., who has taken a great deal of trouble in trying to bore through the shingle, been more successful at Weymouth.

Dungeness and Chesil Banks.

Upon the whole I find nothing to alter my opinion that Dungeness, as well as the Chesil Bank at Portland (the isthmus which connects the island with the main) are both alluvial deposits of clay covered with a superficial stratum of shingle; at Portland, heaped up occasionally to a height of from 20 to 30 feet on the crest of the ridge; at Dungeness seldom exceeding from 8 to 12 feet in depth, and that only on the crest of the wave-like furrows which cover this remarkable shingle waste over an area of about 4000 acres in extent.

Record should be kept.

An accurate record of the movement of the shingle and of the growing out of Dungeness Point, would have been of great value, and it is much to be regretted that none has been kept beyond the single inscription in the lighthouse, that when built in 1792 it stood at 100 yards from the sea.

DOVER BAY.

Dover Bay.

Taking advantage of the spring tides, we anchored the "*Blazer*" in seven fathoms at low water as nearly as possible in the southern entrance of the proposed asylum harbour in Dover Bay, and according to your directions, took up about a gallon of water at different depths and at different states of the tide, namely, from the surface at low water, at half flood, at half ebb, and at high water; also at a depth of 9 feet and 18 feet respectively at half ebb, half flood, and high water, thus producing eight samples of water at different states of the tides, all which are sent to the Museum of Economic Geology for examination as to the quantity of matter held in suspension.

Experiments on water.

As these experiments were made in calm weather, I left my apparatus with Mr. Morgan, of the Revenue Service, with directions to take up the same quantities at similar states of the tide, towards the close of the first gale of wind from the south-west.

From the appearances of the water I do not anticipate that any great quantity of matter will be found in suspension, but even admitting that such should be the case, (and from the recent distur

Round-Down Cliff.

bance at Round-Down Cliff, owing to Mr. Cubitt's masterly explosion, which has driven a quantity of loose chalk into the sea hereabouts, it is fair to expect it for the present,) an easy remedy exists, by

increasing the area of the proposed harbour in Dover Bay, as I fully agree with Mr. Rendel, who tells us in his evidence on this very point, "that the larger the area the more likely to have a successful result." Nor has any instance yet been adduced, as far as I am aware, of a large harbour silting up; Ramsgate, with its insignificant area of 42 acres, receiving all the sewerage of a large town, and situated just at the embouchure of the river Stour, is no case in point. Kingstown, of 250 acres, we learn in evidence, does not silt up, how much less then need we expect such a result in Dover Bay, where the proposed harbour cannot have an area of less than from 500 to 600 acres in extent.

No reason to fear silting up.

I am, &c.,

Admiral Sir Byam Martin, G.C.B.,
&c. &c. &c.

JOHN WASHINGTON, *Captain.*

REPORT ON THE SPECIMENS OF SEA WATER, RECEIVED FROM THE HARBOUR COMMISSION, 5th July, 1844.

Report on Specimens of Sea Water.

Museum of Economic Geology, (Laboratory,)
July 12, 1844.

The bottles containing the sea-water were marked as under, the quantity of each specimen was measured, and the whole submitted to filtration through paper. They yielded the annexed quantities of suspended matter, and I enclose the paper filters by which the matter was separated, and which now contain it. The quantity operated on in each case varied from 182 to 216·6 cubic inches, or about 5 to 6 pints.

DOVER BAY.

2nd July.—Spring Tides—Calm Weather.

		Depth of Water whence taken.	Suspended Matter, per Cubic Foot.
		Fathoms.	Grains.
Low-water	at surface	7	10·21
Half-flood	ditto	8½	13·2
	at 9 feet below surface	7	6·
High-water	at surface	10	3·43
	at 9 feet below surface	8½	7·21
	at 18 feet below surface	7	11·53
Half-ebb	at surface	8½	6·38
	at 9 feet below surface	7	6·92

The quantity of suspended impurity I obtained from Thames water, about four years since, taken at three different places when no rain had fallen for about a month, the water being consequently clearer than usual, was as follows:—

	Grains.
Taken at Brentford—the cubic foot contained of impurity	1·75
,, at Hammersmith ,,	1·83
,, and at Chelsea ,,	4·15

The sea-water impurity, taking the mean of the foregoing statements, is to that of the river impurity as 8·11 to 2·57, or about as 16 to 5.

R. PHILLIPS.

Museum of Economic Geology,
July 25, 1844.

SIR,

IN answer to your letter of this day's date, I beg to state, that the matter ascertained to exist in the Dover water is so very small in quantity, that it would be difficult to ascertain its nature unless a large portion were suffered to deposit at Dover, and the residue were sent to me for analysis.

If I were to give an opinion merely, I should say, that the impurity is composed of some earthy matter, probably chalk and sand, mixed with vegetable matter, *i. e.*, small particles of sea-weed.

I certainly do not consider the quantity of impurity to be large in proportion to the water, and believing as I do, that a portion of it is vegetable matter, I am of opinion, that this, if it were ever deposited, would float off on the slightest agitation.

I have now to report the suspended impurity of the sea-water last sent to me for examination; there were six specimens marked as under:—

DOVER BAY.

17th July.—Spring Tides—Strong Breeze from South-West.

		Depth of Water whence taken.	Suspended Matter, per Cubic Foot.
		Fathoms.	Grains.
Low-water	at surface	7	10·26
Slack-water, flood,	at 9 feet below surface	7	51·29
High water	at surface	10	24·10
	at 9 feet below surface	8½	22·28
	at 18 feet below surface	7	53·76
Half-ebb	at surface	8½	30·93

APPENDIX A.

Report on Specimens of Sea Water.

The quantity operated on was, in each case, about 9 pints; and I forward herewith the filters containing the impurity from each sample.

I have the honour to be, Sir,
Your obedient servant,
R. PHILLIPS.

Admiral Sir T. Byam Martin,
&c. &c. &c.

Museum of Economic Geology, (Laboratory,)
August 2, 1844.

SIR,

CONFORMABLY to the request of the Chairman of the Harbour Commission, I have analyzed a portion of the substances deposited from the sea-water from Dover Bay, and I find that they consist of—

Sand	52·0
Chalk, with a little clay and oxide of iron	24·0
Vegetable matter.	24·0
	100·

I am, Sir,
Your obedient servant,
R. PHILLIPS.

Spencer Westmacott, Esq.,
Secretary.

Extracts from Paper by Mr. William Walker, Plymouth.

EXTRACTS FROM A PAPER, BY MR. WILLIAM WALKER, READ AT THE GEOLOGICAL SECTION OF THE BRITISH ASSOCIATION AT PLYMOUTH.

July, 1841. "I have collected and arranged a few facts in connexion with these animals, and obtained from the breakwater a few specimens to show how they puncture, enter, or perforate the stone. The existence of these shell-fish, (*Saxicava rugosa,*) and their mode of action, as well as the the changes they are capable of producing, may be demonstrated to those who may be sceptical on the subject."

1st. "The buoys placed upon the shoals in Plymouth Sound were formerly moored by chains fixed to large blocks of Portland stone. On examining these stones, after being two or three years in the water, I found them punctured on the surface; and on breaking off portions of the stone, the *Saxicava* was found lodged within it."

2nd. "The sea-walls of the Dockyard at Devonport had been built of Portland stone, and every where below the low-water level of spring-tides, the wall is honey-combed or frittered away."

3rd. "In preparing the foundation of the sea-wall of the Royal William Victualling Yard, at Devil's Point, the diving bell was used to cut away the limestone rock at the bottom, and these rocks were much drilled by the Saxicava. It is between Devil's Point and Mount Edgcumbe, in a channel about 200 fathoms wide, through which the tidal waters of Hamoaze pass. The bottom of the channel as well as both sides of it are of limestone formation, the cliff at Devil's Point on the east side is actually undermined by the *Saxicava*, and the Channel here is three or even four times deeper than Plymouth Sound. The tidal stream here is more rapid than in any other part of the harbour, and consequently the rock, forming the bottom, is kept clean and clear from deposits of mud or sand, we may therefore infer that the great depth of water in the narrows is owing to the operations of the *Saxicava*, as pieces of limestone perforated by these animals have been brought up by my trawl from 20 and 25 fathoms water, south-west from the Ram Head."

"A narrow strip of limestone may be traced from near the Obelisk in Mount Edgcumbe, running in an easterly direction through Stonehouse, Plymouth, and Catwater, consequently the south boundary of the harbour as well as part of its bottom is limestone, and wherever we are enabled to examine these rocks at low-water spring-tides, we find them honey-combed and inhabited by the *Saxicava*, and it is over the limestone bottom where the deep water is to be found."

"Drake's Island and all the shoals near it are of the red sand formation. The island is surrounded with rocks and shoals, a flat sandy bank extends near one-third across the Channel towards Stonehouse, and there are 12 or 15 feet water on this bank, when it terminates at once by plunging into depths of 50, 80, and 120 feet over the rocky limestone bottom.

"From what has been stated, it results, that taking the mean level of the sea as a *zero*, from which to compare relative heights on land or depths in water, the submarine limestone rocks that form the bottom of the sea at Plymouth, are at a *lower level* than the other hard rocks.

"It will be seen by the specimens now produced, that the destruction of the limestone is more rapidly advanced by the innumerable punctures rather than by the perforation of the *Saxicava;* such is the competition for a location in the stone by these minute and numerous settlers, that not one in one hundred obtains an entrance.

"It is not at Plymouth only where these shell-fish are to be found. I found them in the limestone quays in the harbour of Dartmouth, although I am not aware of limestone forming any part of the shores of the Dart. I think, however that Berry Head will be found perforated by them, and that the great depth of water near it may be owing to their operations.

"Engineers employed in the erection of public works, such as quays, docks, basins, or breakwaters, intended to last for centuries, would do well to consider whether limestone of any kind should be employed in such structures below the ordinary level of low water at spring-tides."

REPLIES BY MR. WALKER TO QUERIES PUT BY ADMIRAL SIR BYAM MARTIN, JUNE 10, 1844.

Replies by Mr. Walker to Queries put by Admiral Sir Byam Martin.

Bovisand, June 13, 1844.

1st. Has the *Roche stone* of Portland been employed on the breakwater or other construction at Plymouth, and do the animals, mentioned by Mr. Walker, attack it, as well as the fine grained Portland stone called "block"? Do they attack the cap-stone or hard upper beds of the Portland?—There is not any Portland stone in the Plymouth Breakwater. There is however much Portland stone about the Dockyard sea-walls, and also at the Barbican, and some has been used at the old Victualling-office Point. The large four ton blocks formerly used for mooring the buoys upon the shoals were of coarse stone from Portland. These stones comprise the fine grain in the walls; and also some of the coarsest kind. They have all been more or less perforated by the borers. I have not seen any specimens of the Portland cap-stone used in submarine works. I am, however, of opinion, that as these courses are of the same mineral character as the lower series, (containing lime, shells, &c.,) this stone would be exposed to the ravages of the *Saxicava rugosa.*

General Remark.—I have observed that these animals delight to bore or nibble away the finest and most pure parts of the limestone. This is abundantly apparent in the limestone rocks, now it is dug into holes and crevices, and the protuberant parts left untouched, are found to be impurities, containing earths, quartz, &c.

2nd. Do they touch granite?—They neither touch granite gneiss, porphyry, nor any of those sandstones that contain iron, quartz, nor those rocks of the trap description. In this list the basalts and greywacke rocks should be included.

3rd. Do they touch the hard sandstones—Bramley Fall for example?—The elementary parts of a sand-stone may be either fine, microscopic, or *comminuted* shell, like some specimens from Malta or Portland, &c., or there may be coralines, sponges in it, agglutinated by lime in some form—such stones will be perforated.

If a sand-stone be formed of earthy or quartz particles, which the *pholas* can neither mechanically bore or chemically dissolve, it will not touch it.

If the sandstone have its particles bound together by *an oxide of iron*, as some of the red sandstones have, it is safe from the attacks of marine borers.

Remark.—All the marine boring animals form their cells within the stone, and as I said before, fish from the mouths of their holes. It is therefore surface and clear water they require most. It is remarkable that all our limestone cliffs and promontories are steep and have deep water close to them, provided the waves and tides keep them clean and clear of mud or sand, (for mud or sand kills them.) Portland has deep water everywhere seaward. The Berryhead is limestone, it is quite steep. The water over the limestone in Plymouth Sound and Hamoaze is much deeper than in the Sound, as for example, from the citadel along the north shore and round by Devil's Point to Hamoaze. Haulbowline Island in the Cove of Cork is limestone, the tide of ebb keeps its north side clean, and it is cut almost perpendicularly downwards with six or seven fathoms close to it.

I think that a breakwater might safely have a nucleus of limestone or Portland stone, provided that its crevices and cavities were filled up with solid matter in the shape of rubble, but in order that the structure should be permanent, the limestone should be covered with blocks of granite or other hard and heavy stones, with rubble of the same kind deposited so as to fill up all crevices and solidify the work—a practice which we now pursue here.

Your obedient servant,

WILLIAM WALKER.

Admiral Sir T. B. Martin, G.C.B.,
&c. &c. &c.

CAPTAIN SIR SAMUEL BROWN'S ACCOUNT OF THE DESTRUCTION OF THE WOOD PILES OF THE PIER AT BRIGHTON, AND PROTECTION GIVEN TO THE NEW PILES BY COVERING THEM WITH FLAT-HEADED IRON NAILS.

Sir S. Brown's Account of the destruction of the Wood Piles of the Pier at Brighton.

MY DEAR SIR,

AGREEABLY to your request I now beg to send you a brief description of the destructive effects of the insect called by entomologists Teredo navalis, or Sea-worm, on the piles, diagonal shores, and other framing of the Brighton Pier.

I may first observe, that my original intention was to use "cast-iron piles," diagonal shores, in various parts of the structure, instead of timber, which, coming to the knowledge of Sir Humphrey Davy, he wrote to me expressing his opinion, supported by several facts which had come under his own observation, that the salt water would, in the course of time (but without naming any period) decompose the cast-iron under water, and reduce it to a state approaching to plumbago, which would destroy its metallic property, and of course its stability. Receiving information on this important point from such high authority, I wrote to him expressing my obligations for his valuable communication, and abandoned the project of the cast-iron piles. Before I commenced the Brighton Pier, I had completed the Trinity Pier, near Newhaven, in the Firth of Forth; the outer head of this work is about 750 feet from the bulwark of the beach; the piles were driven about 10 feet into stiff blue clay. In the course of three years the ravages of this insect first became visible; but their destructive effects are so rapid, that in six years the piles, from about half tide to the ground, were reduced from 12 to 14 inches diameter to 9 or 10 inches, and before they were entirely removed and replaced, they were reduced to a mere shred, as shown in the pencil sketch attached. The lower part of these piles had been charred and saturated with boiling coal-tar, in an iron trough made for the purpose. In the course of time all the defective piles were drawn out, and the new timber, which was scarfed to the superstructure, is at this moment in perfect preservation, was filled with scupper nails, which, up to the present time, appears to be an effectual remedy. This pier, which was so essentially necessary, and completely answered the purpose, has, since the construction of the Granton pier (which is about half a mile to the westward) fallen into decay; and as the intercourse will not pay the expense of keeping it up, it will most likely be removed. About two years after the erection of the Trinity Pier, I projected the Brighton Pier, which, as I have just stated, I intended to construct of iron; most unfortunate for the preservation of this work, I was not

Reasons for not using iron piles at Brighton.

Effect of the worm on wood piles.

Effectual protection by iron nails.

Appendix A.

Sir S. Brown's Account of the destruction of the Wood Piles of the Pier at Brighton.

apprised of the ravages of the insect before named, and took no precautionary means, except of saturating the lower part of the piles with hot coal-tar.

It is possible, although we have no means of ascertaining the fact, that this coating may be an effectual defence for a time; but, in the exposed situation of the Brighton Pier, where the sea breaks through with such strong force, it is very soon scoured off, and the first attacks of the insect were so imperceptible, that they had established themselves in myriads before we were aware of the extent of the destruction; and I am inclined to think that this insect is engendered from spawn, or ovæ on the pile. When perfectly formed, it bears some resemblance to a diminutive shrimp; they are constantly at work, and their activity so amazing, that in the course of a few years the whole of the piles in the outer head, which were all 14 inches square, were reduced to 8 or 10 in some parts, and the second and third station were also much injured. But there must be either some difference in the habits of the insect or the quality of the timber; for while some piles have been externally reduced, others have insinuated themselves through the most minute perforation, and without causing any material diminution of the dimensions, some piles have been found nearly gutted. In fact, without troubling you with any further minutia, I may sum it up in a few words. With the exception of four, which it is not intended to remove, and which are now almost severed, the whole of the lower parts of the piles have been cut off about the high-water line, and others driven in their places and securely scarfed to the upper part. Several remedies were proposed in the progress of repairs, but although I was perfectly willing to give all inventors a fair trial, I could not risk the stability of the pier on their reports, however plausible, and I have taken the only remedy which, as far as appearance can be relied on, is quite effectual, viz., that of filling all the new timber with broad head iron nails, resembling scupper nails, but considerably larger; in the course of a few months corrosion takes place, and spreads into the interstices, so that the piles appear to be sheathed with plate iron; probably it might be an improvement worth the attention of the Commissioners to use *square-headed nails*, which leave no interstices.

Further proof of the protection given to wood by iron nails.

This subject must be so closely connected with many of the important objects which the Commissioners have in view, that their researches will not be confined to Brighton, or any particular locality. Wherever we go we find "Teredo Navalis" (or by whatever name designated) exists to a certain extent, and their destructiveness is not confined to timber in salt water alone; for in 1829, when I was building the Union Bridge over the Tweed, I had occasion for timber for a temporary purpose, and I procured some which had been used in the Harbour at Berwick, where the water is slightly brackish, and I found that worms had perforated a very large portion of it. Travelling south we find that this destructive insect exists to a great extent at Sheerness. I have understood that many piles used as fenders to the wharf wall, and which had been coppered, were, notwithstanding, found to be entirely destroyed inside; but there is a case which, although of a limited and partial nature, is, as far as it goes, much more in point, because nearer the locality of the contemplated operations.

I have no doubt you will recollect writing to me (which letter I received in Paris), requesting me to proceed to Deal, and meet the late Lord Liverpool, Sir Edward Owen, and yourself, for the purpose of ascertaining the most eligible situation for the construction of a pier, intended to be similar to the Brighton Pier in all essential points. I met you accordingly at the Naval Yard; this site was fixed on for the purpose, and I received directions from the Navy Board to prepare plans and estimates for the work, which, having complied with, was accompanied with an offer from yourself to construct the pier. In the interim Mr. Traunsell, the storekeeper, had received information that the worms or insects had proved most destructive to timber; in corroboration of this fact, several pieces of wreck, and two or three anchor stocks that had been picked up opposite the yard were completely destroyed, in consequence of which the plan was given up. Previously to trying any chemical preparation, I partially coppered a few of the new footed piles, by woolding them round with spiral stripes of copper two inches wide, as shown in the drawing, but it was soon found that this plan afforded no protection to the intermediate timber, although it certainly preserved it under the copper. This I attribute entirely to the insertion of nails, which suggest the idea that copper sheathing, notwithstanding the failure at Sheerness, may prove an effectual remedy. It must be evident, that as they could not penetrate the copper, or insinuate themselves in the seams, they must have got in at the bottom of the lower sheet, and so worked upwards; now they could have been effectually prevented by driving in two or three rows of copper nails close to the edges of the lower sheet, also the upper sheet if under water, and the copper should in this case reach three or four feet under the surface, where this insect does not arrive. The chemical application for the prevention of the insect was several years ago (Kyan's Anti-dry-rot) applied to a plank nailed at the low-water mark to a pile; in a few years it was quite perforated. About three years ago Pritchard's oil of tar was tried and failed. Payne's process, utter failure. The asphalte, Mathews (the Pier Master) thinks, if it would adhere to the pile it would resist them, but with the utmost care in driving it breaks off. From all these facts, I must come to the conclusion that at present there is really no specific remedy against the attacks of the insect except the iron nails; it is quite clear that it never can, like cast-iron, be reduced to the state of plumbago, and that its total destruction from the effects of corrosion must be very remote. Although you have not adverted to the breakwater, I have no doubt that you have that object almost paramount to all others under consideration. I have a good opinion of Captain Taylor's floating breakwater, and have no doubt of its affording perfect shelter in many situations, and I think it quite practicable to moor it securely so that it would ride out the heaviest gale or sea, but I dread the effects of the worms, for he is too confident in the efficacy of some newly discovered solution which he calls marine poison. If his plan goes on to any extent, which I see no appearance of in this country, he must resort to the iron nails, which will increase his estimate prodigiously. But I hope soon to have the honour of submitting models, which I have nearly completed, of floating and fixed breakwaters which are intended to be constructed of a framing entirely of bronze, which it is known is imperishable in all situations; the spaces between the sloping and horizontal ribs may be filled with any common, cheap material, such as turf, peat, or fascines, not packed together, but close enough to subdue the heaviest waves in passing through it, without opposing a solid front of resistance. Requesting your pardon for being carried so far beyond the subject of your inquiries,

I remain, my Dear Sir,

Your most faithful Servant,

(Signed) Samuel Brown.

To Admiral Sir Byam Martin.

4, *Park Villa, Blackheath;*
6*th June*, 1844.

This Paper is appended to the Report of the "Harbour Commission," shewing the effect of Salt Water on Iron and Brass.

STATE OF THE IRON GUNS WHICH HAVE OF LATE YEARS BEEN WEIGHED FROM SUNKEN SHIPS AT SPITHEAD.

State of the Iron Guns weighed from Sunken Ships at Spithead.

Royal George.

The "Royal George" was upset while at anchor at Spithead in the year 1782, and some guns were recovered from the wreck in 1840, having been 62 years submerged.

Of the iron guns, eight 24-pounders are in the Royal Arsenal at Woolwich. The edges of the mouldings are gone, and the incrustation of oxide extends in general to the depth of one-eighth of an inch, below which the metal appears to be in its original condition.

Of the brass guns, six 12-pounders and four 24-pounders remain in the Arsenal, and the metal appears to be uninjured, the mouldings and devices remaining perfect. These guns were cast in cores, supported in their places by iron bars, or cross-heads, which were left embedded in the metal at the base-ring of the piece. The iron has entirely perished, and may be dug out like earthy matter.

Four 24-pounders were repaired by filling up the holes left by the iron bars, and proved with 18 pounds of powder and a shot; and in 1841 sent on board the "Howe" at Sheerness as show-guns.

The Edgar.

The guns of the "Edgar" were 133 years under water. The brass guns appear to be uninjured, but the iron guns are corroded to the depth of three-quarters of an inch, and the shot found in them to the same extent; the metal below it appears perfect. The oxidized crust has rather hardened during the last *few years*. The guns are of charcoal iron.

Mary Rose.

The "Mary Rose" was upset when under sail at Spithead, in the year 1545; the guns were 292 years under water. The brass guns are considerably honeycombed, though not generally over the surface of the metal. But the iron guns, specimens of which are in the Arsenal, are of the ancient construction, of wrought iron bars bound with hoops, and having detached chambers keyed into beds of solid wood, are corroded to the depth of a quarter of an inch. They appear to have been covered, and in some degree protected, by the mud.

The iron shot from the guns of the "Mary Rose" became gradually red-hot on coming into the atmosphere, and split and fell to pieces like dry clay.

Appendix B.

LETTERS, &c., ISSUED.

1. Sir Byam Martin to Captain Hornby, Comptroller-General of the Coast Guard, requesting that the officers of the Coast Guard may be directed to give any assistance required by the Commission.—*April* 17, 1844.
2. Sir Byam Martin to the Secretary of the Admiralty, requesting that Captain Bullock might be instructed to make a survey at Dungeness.—*May* 3, 1844.
3. Sir Byam Martin to the Commissioners of the Customs, requesting the officers belonging to that department might be directed to render any assistance required by the Commission.—*May* 4, 1844.
4. Sir Byam Martin to his Grace the Duke of Wellington, requesting that the officers of the Cinque Ports may be directed to give any assistance required by the Commission.—*May* 4, 1844.
5. Sir Byam Martin to General Sir George Murray, requesting that the officers of the Ordnance Department stationed at Dover, might be directed to assist the Commission in their inquiries.—*May* 7, 1844.
6. Sir Byam Martin to Captain Washington, R.N., directing him to proceed to Portsmouth.—*May* 18, 1844.
7. Sir Byam Martin to Captain Washington, directing him to assist in carrying out the survey of Portland by Captain Sheringham, if required.—*May* 18, 1844.
8. Sir Byam Martin to Lord Lincoln, requesting that the granting of a new lease of the Crown Quarries at Portland may be deferred.—*May* 28, 1844.
9. Sir Byam Martin to the Secretary of the Admiralty, notifying the satisfactory completion of the survey of Portland by Captain Sheringham.—*May* 29, 1844.
10. Sir Byam Martin to Captain Washington, directing him to proceed to Harwich.—*May* 29, 1844.
11. Sir Byam Martin to Lieutenant-Colonel Harry Jones, R.E., requesting his opinion on the proper section for the sea slope of breakwaters.—*June* 1, 1844.
12. The Secretary to James Walker, Esq., referring to the letter from the Admiralty of the 12th June, and requesting him to supply information upon the breakwater at Plymouth.—*June* 13, 1844.
13. The Secretary to J. Hussey, Esq., M.P., notifying that the paper respecting a harbour at Lyme Regis should be laid before the Commission.—*June* 8, 1844.
14. Sir Byam Martin to the Chairman of Lloyd's, requesting to know whether any of that body were desirous of giving the Commission their views on the subject of Harbours of Refuge.—*June* 19, 1844.
15. Sir Byam Martin to G. F. Young, Esq., Chairman of the Ship Owners' Society, requesting that he would afford the Commission any information he might see proper on the subject of their inquiries.—*July* 14, 1844.
16. Secretary to Captain Kerr, R.N., respecting borings to be made at the Chesil Bank.—*June* 19, 1844.
17. Sir Byam Martin to Captain Peat, R.N., respecting borings to be made at Dungeness.—*June* 21, 1844.
18. Secretary to Captain Peat, requesting that specimens of the water from Dover Bay may be sent for examination.—*July* 5, 1844.
19. Sir Byam Martin to Mr. Cubitt, requesting any further information respecting the deposits of silt in Folkstone Harbour.
20. Sir Byam Martin to the Harbour Master at Ramsgate, with inquiries as to the deposits of silt at that place.

APPENDIX C.

LIST OF PROJECTS, PAPERS, MODELS, &c., SUBMITTED TO THE HARBOUR COMMISSION.

Captain Hood.—A project for the improvement of the tidal harbour of Newhaven and Cuckmere, by deepening the harbour, extending the piers, and forming Sleepers' Hole into a reservoir for a sluicing power.—See evidence.

Mr. Stevens, Harbour Master, Newhaven.—To widen and deepen entrance of harbour—to widen also within the pier heads, and carry the piers out.—See evidence.

Mr. Jessopps.—Project for Newhaven. To form Sleepers' Hole into a basin five acres in extent.

Sir Henry Shiffner.—Project for Newhaven. Sleepers' Hole to be formed into a basin, with dry docks at either end; also a breakwater in Seaford Bay.

Mr. Carey.—To excavate docks and basin at Newhaven.

Mrs. Henry Ogle.—Proposing a breakwater in Eastbourne Bay, and docks or basins in the Crumble Lakes.

General F. Maitland.—A basin to be formed in Romney Marsh, a mile square, with two entrances, one at Rye, and the other at Hythe.

Captain Vetch.—The Goodwin Sands to be formed into an island, by encouraging, by certain artificial means, the deposit and retaining of the sand; also to redeem the Sandwich Flats.—See evidence.

Mr. Bush.—The construction of a harbour, by sinking iron caissons on the substratum of the Goodwin Sands, enclosing the sands by a sea-wall 11 miles in extent, affording a harbour within of 2260 acres, with an average depth of six fathoms at low-water spring-tides.—See evidence.

Mr. Mitchell.—To enclose and deepen a space for a harbour, by the sinking of cast-iron caissons on the Goodwin Sands, and concreting.

General Ford, R.E., the late.—Report upon a project for a breakwater in Dover Bay.

Mr. Steward.—Proposal for a breakwater in Dover Bay, detailed in his evidence.

Mr. Jeffreys.—For the improvement of the entrance to Dover Harbour, by removing a bed of chalk on which he states that the shingle rests. Also for forming a harbour of refuge in Dover Bay.—See evidence.

Proposition for a breakwater harbour in Dover Bay, by Captain Vetch, R.E.—See evidence.

A Memorial from 456 Inhabitants of New Romney, Lydd, and the vicinity, respecting a harbour at Dungeness.

Mr. Calver, R.N.—To form an internal harbour at Dungeness, with two entrances on a novel principle.

Mr. Barrett.—An internal harbour at Dungeness.

Mr. Johnstone.—An internal harbour at Dungeness.

Mr. Potter.—Improvement of Rye Harbour, and the construction of a breakwater in the West Bay at Dungeness.

Mr. Calver.—An inner harbour at Lowestoft Ness.

Messrs. Lamb, Bush, and Harvey.—Projects for a breakwater at Portland (already published).

Captain Taylor.—To cut through the Chesil Bank at Portland, and connect the two bays; also his proposition for "submarine breakwaters," and a floating breakwater outside as generally applicable.

Mr. Calver, R N.—To cut through the Chesil beach at Portland, and connect the bays.

Rev. Thomas Kingdon.—A suggestion that a harbour of refuge be established on the south-west coast of Cornwall, about 10 miles from Launceston; mentioning a point near Widemouth, named Melluck, for the position.

Proposition for increasing and extending the harbour of Lyme Regis for the reception of large craft; forwarded by the Mayor.

A Memorial of Shipowners and others, suggesting the improvement of the harbour and erection of a breakwater at Brixham—Torbay.

Mr. Johnston.—Breakwater at Brighton, fully described in Report of Shipwreck Committee.

Mr. Barrett on the subject of the Formation of Bars.—See evidence.

APPENDIX C.

Mr. T. W. Tanner.—Essay on harbours, deposits, bars, &c.

Mr. Prichard on Bar Harbours.

Mr. Doull.—Proposition for a Lighthouse on the Goodwin Sands.

Mr. T. F. Cook.—Proposition for the Prevention of the accumulation of Shingle at Dover.

Mr. Newman.—A project for a Breakwater at Portland.

Mr. Fraser.—An Essay on Harbours and Bars.

Mr. White.—Proposition for a floating Breakwater.

Captain Sir Samuel Brown.—Model of a floating Breakwater formed of bronze bars, packed with turf or cork, and rendered buoyant by cylinders combined with the structure.

Also a Model of a fixed Breakwater of bronze, capable of being floated to its place, or weighed again by attaching cylinders.

Captain Vetch, R. E.—Model of a project for a Pier constructed of upright iron rods, made solid with concrete, cased in brickwork above low-water level.

Also a Model of a Screen or Breakwater formed with vertical iron rods, supported in a frame of a triangular section, and proposed to be erected in crossing a tideway, where it is desirable not to interrupt the stream and scour.

Dr. Potts, M. D.—Model of a Pneumatic Machine, by means of which iron cylinders may be sunk, and foundations formed in deep water.—See evidence.

Mr. W. H. Smith.—A Model of a floating wooden Breakwater and its moorings.—See evidence.

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TIDAL HARBOURS COMMISSION.

FIRST REPORT

OF

THE COMMISSIONERS.

Presented to both Houses of Parliament by Command of Her Majesty.

LONDON:

PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET,
FOR HER MAJESTY'S STATIONERY OFFICE.

1845.

CONTENTS.

	PAGE
COMMISSION	iii
REPORT	v—xiv
MINUTES OF EVIDENCE	1—140
APPENDIX	141—202
ANALYSIS OF EVIDENCE	203

LIST OF PLATES.

1. Plan of the River Clyde
2. Plan of the River Tay
3. Plan of Southwold Harbour and the River Blyth
4. Plan of Harwich Harbour
5. Plan of Rye Harbour

At the end of the Volume.

COMMISSION.

VICTORIA, BY THE GRACE OF GOD, of the United Kingdom of *Great Britain* and *Ireland* Queen, Defender of the Faith. TO Our trusty and well-beloved *William Bowles*, Esquire, Companion of Our Most Honourable Military Order of the Bath, Rear Admiral of the Blue Squadron of Our Fleet Sir *James John Gordon Bremer*, Knight, Commander of Our Most Honourable Military Order of the Bath, Captain in our Navy, *Joseph Hume*, *Aaron Chapman*, *Edward Royd Rice*, and *Thomas Baring*, Esquires, Our trusty and well-beloved *Francis Beaufort*, Esquire, Captain in Our Navy, Hydrographer of Our Admiralty, or the Hydrographer of Our Admiralty for the time being, *George Biddel Airy*, Esquire, Our Astronomer, or Our Astronomer for the time being, Our trusty and well-beloved *John Washington*, Esquire, Captain in Our Navy, and *Richard Godson*, Esquire, Counsel for the Affairs of Our Admiralty and Navy for the time being, greeting: WHEREAS We did by our Letters Patent under the Great Seal of Our United Kingdom of Great Britain and Ireland, bearing date at Westminster the First day of February, in the Eighth year of Our Reign, nominate, constitute, and appoint you the said *Joseph Hume*, *Aaron Chapman*, *Edward Royd Rice*, *Thomas Baring*, *Francis Beaufort*, or the Hydrographer of Our Admiralty for the time being, *George Biddel Airy*, or Our Astronomer for the time being, and *John Washington*, together with our right trusty and well-beloved Councillor *Henry Thomas Lowry Corry*, and Our trusty and well-beloved *Henry John Shepherd*, Esquire, to be Our Commissioners for inquiring into the state and condition of the Harbours, Shores, and Navigable Rivers of Our United Kingdom of Great Britain and Ireland, and as to the powers of the Commissioners deputed and assigned for Executing the Office of Our High Admiral of Our said United Kingdom of Great Britain and Ireland for the conservation of the same; And also what measures might be necessary for removing and preventing impediments to Navigation: NOW KNOW YE that We have revoked and determined, and by these presents do revoke and determine, the said recited Letters Patent, and every clause, article, and thing therein contained: AND FURTHER KNOW YE that We, confiding very much in your fidelity, discretion, diligence, and careful circumspection, of Our especial Grace, certain knowledge, and mere motion, have nominated, constituted, and appointed, and by these Presents do nominate, constitute, and appoint you the said *William Bowles*, Sir *James John Gordon Bremer*, *Joseph Hume*, *Aaron Chapman*, *Edward Royd Rice*, *Thomas Baring*, *Francis Beaufort*, or the Hydrographer of Our Admiralty for the time being, *George Biddel Airy*, or Our Astronomer for the time being, *John Washington*, and *Richard Godson*, or Our Counsel for the Affairs of Our Admiralty and Navy for the time being Our Commissioners for the purposes herein after mentioned.

AND We do by these Presents give and grant unto you, or any five or more of you, full power and authority to inquire into the state and condition of the Tidal and other Harbours, Shores, and navigable Rivers, of Our United Kingdom of Great Britain and Ireland; and to ascertain what changes have taken place in any of such Harbours, Shores, and Rivers, as respects Bars, Entrance, Depth of Water, extent and amount of Scour, or otherwise, and what encroachments have been made upon them, or upon the Waters above such Harbours and Rivers, by Enclosures of Lands, Embankments, Wharfs, Piers, or other works, and by whom and by what authority such Encroachments have been made, what effect they have or may hereafter produce, and also what injury may have been done, or may accrue, by the removal of Shingle, Rock, Soil, or other materials, from any Shores, or by the emptying Ballast or other materials into or near any such Harbours and Rivers, or in consequence of Wreck not being removed, and what measures are necessary and expedient to remedy and prevent any injury that may have resulted, or may be likely to result, therefrom; and also whether there are sufficient powers for enforcing such remedy, and whether any and what further powers are necessary.

AND We do further by these presents give and grant unto you Our said Commissioners, or any five or more of you, full power and authority to inquire into the present state of the Law as regards the powers of the Commissioners deputed and assigned for executing the Office of Our High Admiral of Our United Kingdom, for the conservation of all Harbours, Shores, and Rivers of Our said Kingdom; and how far the powers given to any Bodies Corporate, Commissioners, Trustees, Local Authorities, or other persons, by any Charters or other Acts of Us or of Our Predecessors, Kings and Queens of England, Scotland, and Ireland, or by any public, local, or private Acts of Parliament, supersede or interfere with the powers and authority of the Commissioners assigned and deputed to execute the Office of Our High Admiral of Our United Kingdom; and whether any, and, if any, what legislative measures or other acts are necessary to confer upon the same Commissioners sufficient powers to remove or prevent encroachments, or the constructions of any work, or for the removal of wreck, or for preventing any act which has or has a tendency to have an injurious effect on any Harbour, Shore, or navigable River of Our said United Kingdom.

AND We do further by these Presents give and grant unto you Our said Commissioners, or any five or more of you, full power and authority to inquire and ascertain what measures you may deem expedient for the improvement of the Harbours and Rivers of Our same Kingdom.

AND We do further by these Presents authorize and empower you, or any one or more of you, to visit and personally inspect all the Harbours, Shores, and navigable Rivers of Our United Kingdom, or such of them as you may deem expedient, and to employ Engineers and other persons to make surveys of such Harbours, Shores, and navigable Rivers, who are to report thereon to you.

AND We do by these Presents give and grant to you, or any one or more of you, full power and authority to call before you, or any one or more of you, at any place you, or any one or more of you, may think necessary, such persons as you, or any one or more of you, shall judge requisite by whom you may be better informed of the truth in the premises, or from whom you, or any one or more of you may consider it desirable to obtain information for the purposes of this Commission, and to inquire into the same, and every part thereof by all other lawful ways and means whatsoever.

AND We do further by these Presents give and grant to you, or any one or more of you, full power and authority, where the same shall appear to you, or any one or more of you, to be requisite, to administer an oath or oaths to any person or persons whomsoever to be examined before you, or any one or more of you, touching or concerning the premises.

AND Our further Will and Pleasure is that you, or any five or more of you, upon due examination of the premises, do and shall report to Us in writing, under your hands and seals, your observations as to what you shall find touching or concerning the premises upon the said Inquiry; and also your opinions as to the amendment, if any, of any of the existing Laws having reference to the objects of this Commission.

AND We further will and command, and by these Presents ordain, that this Our Commission shall continue in full force and virtue, and that you Our Commissioners shall and may from time to time proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

AND We do hereby direct and appoint that you, or any five or more of you, may have liberty, should you deem it expedient, to Report to Us your several Proceedings under this Commission from time to time, as the same shall be respectively completed and perfected.

IN WITNESS whereof We have caused these our Letters to be made Patent. WITNESS Ourself at Westminster the Fifth day of April, in the eighth year of our reign.

By Writ of Privy Seal.

EDMUNDS.

REPORT.

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

WE, the undersigned Commissioners, appointed by Your Majesty to inquire into the state and condition of the Tidal and other Harbours, Shores, and navigable Rivers of Great Britain and Ireland, humbly beg leave to report our proceedings in the execution of Your Majesty's Commission.

The various points of inquiry to which our attention is directed in the instructions given to us for our guidance may be conveniently classed under four heads, viz. :—

First.—As to what changes have taken place in any of those tidal harbours or navigable rivers.

What encroachments have been made upon them; by whom and by what authority so made; and the effect that such encroachments have produced or may hereafter produce.

What injury may have been done to those harbours and rivers, or may accrue to them by neglect, or by the unauthorized removal of shingle or other materials from their shores, or by the improper discharge of ballast, or by the drainage of mines, or by the diversion of their tides or streams.

Secondly.—What measures are necessary as well to abate any of the said injuries as to prevent any future mischief.

Whether there are sufficient legal powers for enforcing such remedy, and if not what further powers are necessary.

Thirdly.—To inquire into the state of the law as regards the powers of the Lords Commissioners of the Admiralty for the conservation of all the harbours, shores, and rivers of the United Kingdom.

How far the powers conceded to particular authorities or persons, by Charter or by Royal Grant, or by Act of Parliament, may be held to supersede or to interfere with the jurisdiction of the Admiralty.

Whether any, and what, Legislative measures are necessary to give the Lords Commissioners of the Admiralty sufficient powers to remove any present or future encroachments, and to prevent the construction of any works which may have an injurious effect on any harbour, shore, or navigable river.

Lastly.—To inquire what measures it may be expedient to adopt for the general improvement of the harbours and rivers of the United Kingdom.

We entered on these several points of inquirywith a full sense of their deep importance, not only as involving the general benefit of the public and the protection of our commerce, but also the welfare of a large class of Your Majesty's most valuable subjects, the merchant seamen of this great maritime empire; and it is our earnest hope that we may be enabled to point out simple and efficacious means whereby our tidal harbours may be rendered more available to the prosperity of our commerce and more accessible in the hour of need.

The labours of the Commission have been anticipated, in some measure, by the Orders of the House of Commons of the 22nd July and 9th August last; in compliance with which Returns have been received from 260 harbours and havens governed by Act of Parliament, Charters, &c., comprising a mass of valuable information respecting the tidal harbours and navigable rivers of the kingdom, which will require much time to examine carefully, and to form a digest of them. But having in an early stage of our Inquiry become deeply impressed with the necessity of some Legislative measure to be taken with as little delay as possible to remedy the injuries which have already taken place (and are daily increasing) to the navigation of many of the tidal harbours throughout the United Kingdom, we determined to confine our inquiries in the first instance to a few specific cases bearing directly on that general question.

See App. p. 143.

We have therefore selected, as examples, the rivers Clyde and Tay, and the harbour of Montrose, in Scotland; together with Southwold, Harwich, and Rye, in England; and we find that very great and increasing injury to the best interests of the country has accrued from negligence of the several authorities in permitting the improper removal of soil and beach, as well as by embankments, weirs, and other obstructions of a similar nature which check the free flow of the tide, impair its strength, and thus permanently diminish the general depth of the river. And, on the other hand, that when the aid of experience and science has been called in, and a due vigilance has been exercised, a proportionate improvement has invariably been the result.

THE RIVER CLYDE AND HARBOUR OF GLASGOW.

See Plan in App.

The river Clyde offers an instructive example of what enterprise and persevering efforts will accomplish, but at the same time a proof that even such efforts require to be controlled by some competent and disinterested authority.

This noble river, traversing a large part of the western lowlands—the third Scottish stream in point of magnitude, but the first in commercial importance—drains an area of 1200 square miles, or a twenty-fifth part of the whole of Scotland.

Smeaton, 1755. Golborne, 1768. Watt, 1769. Smeaton's Rep. p. 1.

From the reports of the Engineers Smeaton, Golborne, and Watt it appears that, about 90 years since, the navigation of this river, as well as the flow of the tide, was so much obstructed by sand-banks, that barges drawing 3 feet water could alone be employed in the trade of the important city of Glasgow; that its manufactures were necessarily carried down to Port Glasgow or Greenock in order to be shipped for exportation; and its imports, in the same manner, were transhipped into barges to be brought to the city. At this time the rise of spring tides at Hirst Sand, a little below Glasgow, was only 1 foot 9 inches, and the total depth at high-water spring tides was but 3 feet 3 inches. So hopeless did the case seem, that in 1755 Smeaton proposed a lock across the river at Marling Ford, about four miles below the city, so as to form the upper part of the river into a canal; and for this an Act of Parliament was actually obtained. Happily, however, for the commercial interests of Glasgow, Golborne, in 1768, took a different view of the capabilities of the river, and recommended the contraction of the channel and the free use of the dredge. These means having been adopted, and perseveringly employed by subsequent engineers, the result is that at this moment there is a depth of 17 feet at high-water at Glasgow Quay, and that large ships now embark and unload their cargoes where formerly a laden barge could barely swim.

Golborne's Rep. p. 2.

Question 29.

	Vessels.	Tons.
In 1844 the number of arrivals was . . .	13,919	of 1,101,949

Parl. Papers, No. 349, for 1845; and App. p. 163.

And there are now 60 steam-vessels belonging to the port; as well as 940 arrivals and sailings annually of traders, not one of which, at the former period, could have approached nearer than Dumbuck Ford, 12 miles below the city.

These are great improvements, and highly honourable to the spirit and enterprise of this city, yet it must be remembered that such results have been obtained at a vast sacrifice of money levied by heavy dues upon shipping, which nothing but great commercial prosperity could have borne.

Evidence on Clyde Navigation Bill.

	£
In 1770 the gross harbour dues for the year were . .	147
In 1841 ,, ,, . .	50,292
And the total receipts since the year 1770 exceed . .	800,000

But engineering skill being not only slow in its development, but having often to struggle with prejudice and self-interest, it has now been discovered that many of the plans of the Clyde Trustees were short-sighted; that in order to continue their improvements in deepening their river, they must now submit to a large outlay for rebuilding bridges, the foundations of which were not laid deep enough; that weirs have been permitted across the river, nay, sanctioned by Act of Parliament, so as to prevent the flow of the tide above the city, and stop all navigation above the bridges; that a considerable expense for dredging might have been saved if the natural flow of the tidal water had been properly

49 Geo. III. cap. 74.

directed; the harbour space might have been enlarged, and the general depth of water throughout the river increased; and that, with all these improvements, the dues on shipping might have been lightened, and the ports of Greenock and Port Glasgow, at the mouth of the Clyde, might have been spared a large expenditure in the construction of docks, made in expectation of traffic which it is not probable will ever now be realized.

THE RIVER TAY.

The river Tay is the largest of all the Scottish streams; its extreme length being about 180 miles, draining an area of 2300 square miles, and pouring more water into the ocean than any other river of Great Britain. In point of commercial consequence, it is inferior to the Clyde; but the rapid strides made by Dundee within the last 10 years, and the increase in the shipping at Newburgh and Perth, make the preservation of this river a subject of great importance, and render it the more necessary to show how much it had suffered while it was abandoned, and how satisfactory have been the results since improvements began. See Plan. in App. Q. 403—409.

Down to the year 1834 the upper portion of the Tay, as far as navigation was concerned, seems to have been entirely neglected. Landed property on each side of the stream, and the right of salmon fishing, seem to have been paramount to every other interest: jetties or dikes, in order to form new ground, were run out at pleasure; and large heaps of stone, called fishing cairns, were erected at will in the bed of the stream; while, below, only a single fairway buoy was placed to mark the entrance between two dangerous sands at the mouth of the river. The Perth Commissioners at length became alive to the mischief of neglect; a strong report from their engineer on the shameful state of the river and on its capabilities roused them to activity, and in 1834 a Bill was obtained to empower them to raise money for its improvement. During the next five years the process of deepening the bed and straightening the channel of the river was steadily continued, and by thus affording a free passage to the tidal waters a depth of 15 feet at high-water of spring tides has been obtained near the city, and the flood tide now begins to flow three-quarters of an hour earlier than formerly at Perth bridge. Q. 290—294. Q. 342—344. Q. 355—360.

The value of such unrestrained action to the tidal waters seems not to be confined alone to the upper channel of the river, for according to the report of the Admiralty surveyor, (printed in the Appendix,) it has caused an increase of depth at the Tay Bar, and dispersed a large quantity of the sand which had there accumulated. The signal success of these efforts in the Tay as well as the Clyde, holds out great encouragement to persevere in deepening the channels in all our tidal rivers. App. p. 154.

Nor have the trustees of Dundee Harbour shown less energy in keeping pace with the extension of manufactures in their town; by the establishment of suitable docks and basins they have raised it to be a first-class commercial port; and by their judicious enterprise during the last 30 years they have more than quadrupled the number of its shipping as well as the amount of its revenue.

	£.
In June, 1815, the total revenue of the port was . .	4,096
In June, 1844, „ . .	23,895;

Printed Abstracts of Income and Expenditure.

while the number of vessels had increased to 3791, having a burthen of 272,239 tons.

The Tay is however susceptible of much further improvement: there are still many obstructions in the bed of the river to be removed; dangerous rocks near the entrance of the inner harbour at Dundee are yet to be blasted; and a recent attempt, to grasp an area of about 2000 acres below high-water mark, near Powgavie, on the north shore, has to be frustrated. In short, here as elsewhere, the watchful eye of a permanent conservative guardianship is absolutely required in order to preserve this fine river for its daily increasing trade. Admiralty Survey. Rep. App. p. 155. Q. 425—430.

MONTROSE

At Montrose we find a similar instance of encroachment on the banks of the South Esk (the details of which appear in the evidence), where the proprietor of the adjoining land even questions the authority of the Admiralty to oblige him to restore to the harbour a part of the tidal water of which it appears Q. 1574—1657.

it has been deprived by his embankments. The Montrose Trustees having, with
Q. 1670. much public spirit, recently expended the large sum of 42,000*l.* in constructing a wet dock and in improving their harbour, have not the means of contesting with a wealthy proprietor, the point at issue, and therefore naturally look to the Admiralty for protection. But as this case is now in course of legal process by the Lord Advocate of Scotland, we abstain from further comment.

ARBROATH.

Q. 1058—75 Arbroath, a port on the east coast of Scotland, about halfway between Montrose and the river Tay, and the seat of extensive manufactures, falls under a different head of inquiry from the harbours we have hitherto examined into, but is not the less, we conceive, within the limit of our instructions.

The evidence laid before the Commission evinces an extent of public spirit on the part of the inhabitants and trustees of this burgh in the highest degree
Q. 1045. deserving encouragement. Seven years ago the harbour was the property of the Corporation, and its revenues were applied in lighting, paving, and cleansing the streets. The harbour was insufficient for the shipping belonging to the place, and unfit for the reception of vessels of any considerable size. But in the year 1838 the inhabitants voluntarily came forward and taxed themselves in order to pay those municipal expenses; and an Act of Parliament, in 1839,
Q. 975—6. having empowered the trustees to raise money, a sum of not less than 58,000*l.* has been since that time expended in works for enlarging and improving the port, whereby the accommodation for shipping is more than doubled.

Arbroath Memorial in App. p. 161.

	£
In 1746 the shore dues amounted to . . .	21
In 1823 „ „ . . .	616
In 1843 „ „ . . .	3050

showing, since the internal improvements of the port, a rapid increase in the amount of traffic.

But the estimated expense of executing those works, as in nearly all similar cases, has proved too small. As far as they have been carried out they are constructed with deep foundations, and are of a substantial and stable character.
Q. 1003. But the deepening of the harbour, with its entrance and approaches, is still unfinished; and having exhausted all their resources, the trustees have memorialized Your Majesty's Government for a small grant, to enable them to complete the projected works; without which, what has been done will be in a great measure unavailable.

The works proposed, it appears in evidence, would give a mean depth of
Q. 1021. 16 feet at high-water of ordinary spring-tides,—they would render Arbroath a tidal harbour of refuge, for 12 hours out of the 24, for all vessels of the size which usually frequent that coast; and they would thus be as great a benefit to the public as to their enterprising owners; for the greater part of that rocky coast, when it becomes a lee-shore, is extremely dangerous, as was too fatally
Q. 1027. proved in the gale of January, 1800, when 40 vessels were wrecked, and 13 of them within a few miles of Arbroath.

Taking all the above-mentioned circumstances into consideration, it appears to the Commission that this case comes so distinctly under the fourth head of inquiry pointed out to us by our instructions, that if in any instance Your Majesty's Government should be disposed to aid the local exertions of the trustees of a harbour, this case seems deserving of encouragement, and we therefore humbly beg leave to recommend to Your Majesty the prayer of the Trustees of the Harbour of Arbroath.

THE RIVER BLYTH AND HARBOUR OF SOUTHWOLD.

In the northern portion of Your Majesty's dominions we have seen that although great want of vigilant control is manifest, and that the landed, and fishing, and corporation interests have too often been preferred to the rights of merchants and ship-owners, and to the general interests of navigation, still the spirit of commercial enterprise has finally broken through the barrier, and by degrees has carried out, to a certain extent, improvements in some of the harbours. In the southern ports, which we have now to notice, we regret to report that those interests have proved too powerful, and that the consequence has been in several cases a dry bar, a deserted port, and all but ruin to the ship-owner and merchant.

The river Blyth and the port of Southwold on the east coast of Suffolk offer a strong proof of the correctness of these statements. See Plan.

It appears in evidence that the whole area formerly covered by the spring-tide waters of the river Blyth was about 2,000 acres, and that by means of the several embankments shown in the accompanying plan, that area has been reduced to 450 acres, or less than a quarter of the whole extent It likewise appears that over more than half the original area the depth at high water ordinary springs would be two feet; that in the event of high springs it would be four feet, and in north-west gales or equinoctial springs, fully six feet. We have thus the means of computing roughly the quantity of water which has been excluded by these embankments ; and taking the lowest estimate, or that of a common spring tide, it gives, in round numbers, 150 millions of cubic feet, or $4\frac{1}{2}$ millions of tons on every tide ; and as three such tides occur at each new and full moon, or seventy-eight in a year, some notion may be formed of the enormous loss of scouring power sustained in consequence of these embankments. Engineer's Rep. in App. p. 171. Admiralty Survey. Rep. App. p. 173. Engineer's Rep. in App. p. 172.

The merchants of Halesworth (the great corn mart of this part of the county of Suffolk) had repeatedly urged the propriety of deepening the bed of the Blyth; yet nothing was done till an Act of Parliament was obtained in 1830, and though under direction of the present harbour Surveyor, the lower part of the harbour has been somewhat improved ; yet as the Act did not touch the embankments, the bar has been at times since that period dry at high water, so that no vessel could get in or out. Q. 1114. Q. 1143.

As a general, although not universal principle, no cause has operated more extensively to injure the entrances of harbours throughout the United Kingdom than excluding the tidal waters from lands below the level of high-water, which served as natural reservoirs for the flood tide, and were the means of affording a valuable scouring power during the ebb. Nor does any subject more deserve the vigilant attention of Your Majesty's Government, or of those entrusted with the conservancy of our harbours, than such encroachments, which are usually made quietly and gradually, and when once completed are difficult afterwards to remove.

It appears in evidence that, with the exception of two, the Southwold Harbour Trustees are self-elected ; they consist of landed proprietors, merchants, &c., but only a single sailor. Q. 1121—33.

We have thought it right to enter into the above details, since Southwold is entirely dependent upon tidal waters for existence as a port, and since the value of the daily tidal scour in all our harbours does not seem to be sufficiently appreciated; nor can any case more strongly prove the duty of jealously guarding against similar encroachments.

HARWICH HARBOUR.

The ancient and well-known port of Harwich is an estuary formed by the junction of the rivers Stour and Orwell, and contains about 700 acres of good anchorage. The value of this port was well understood during the last war, and will be so again when we have occasion for another North Sea fleet. It was from Harwich that the fleet was watered by transports ; and that all its vessels obtained supplies at the naval yard ; here not less than 60 ships of war have been built, 15 of which were two-deckers ; and the fishing vessels belonging to the port some years since were estimated at 3000 tons, and employed 500 of our most hardy seamen. See Plan in App. Admiralty Survey. Rep. App. p. 176.

Its general depth of water, its wide extent, its perfect shelter, its easy access by night or by day, in all weathers, and in all states of the tide, render Harwich the only harbour of refuge, properly so called, between the Thames and the Humber.

Yet it will be seen from the plan annexed to this Report, and from the evidence taken before the Harbour of Refuge Commission of 1844, that this harbour, which in easterly gales has given shelter to 500 sail of shipping at once, has been suffering a rapid deterioration during the last 30 years from the removal of the cement stone at the foot of Beacon Cliff and Felixstow Ledge. The consequence is, while the sea has gained considerably upon the Essex shore, threatening to break through the isthmus, that Landguard Point, on the opposite side, has advanced 500 yards upon the sea during the same period, Q. 1220—24. App. p. 176.

Admiralty Survey. Rep. App. p. 176.

thereby blocking up the chief entrance into the harbour; and so much so, that where, in the year 1804, there was a channel seven fathoms deep at low water, there is now a shingle-beach as many feet above high-water mark.

But the attention of Your Majesty's Government having at length been called to this state of neglect by the Report of that Commission, it appears that immediate measures are to be taken to restore this port to its former value as a Harbour of Refuge.

RYE HARBOUR.

See Plan in App.

Rye, one of the Cinque Ports, on the coast of Sussex, lies in the bight of a bay, about three miles deep, bounded by Dungeness to the east, and Fairlight Head to the west. The present harbour is in the lower part of the channel of the river Rother, and just below the junction of the Tillingham and the Brede, two small streams flowing from the north-west. A rubble-stone pier, which does not reach within 1200 yards of low-water mark, is in the course of construction on the eastern side of the harbour, and an embankment of earth has been thrown up on the western side, leaving an entrance between of 290 feet in width.

Q. 2186.

The average rise of spring-tides at the town of Rye is 14 feet, at the pier-head 17 feet, and in the bay 23 feet, or greater than anywhere on the south-eastern coast of England. At low-water the harbour is left dry.

For several miles round the town of Rye, and immediately adjacent to the harbour, there are large tracts of marsh land, the greater part of which are owned by proprietors residing in the neighbourhood. Over a great portion of this plain the sea was formerly accustomed to flow at every tide, and thus formed a considerable back water, which operated as a scour to the harbour of Rye, and kept the channel open. The proprietors, however, uncontrolled by any guardian of the port, began by degrees to exclude the tide, and no steps being taken to restrain their encroachments, they obtained an Act of Parliament, erected dams and sluices across the rivers a short distance above the town, and finally excluded the tidal waters.

By these means hundreds of acres of marsh have been reclaimed, while the harbour, deprived of its back waters, yielded to the mass of sand and shingle which rolled in with every wave, and which have now nearly obliterated the appearance of a channel.

Rennie's Rep. in App. p. 193.

Three rivers drain this tract of country; and had there been no obstructions in their channels, they would have afforded an ample reservoir for tidal waters; and indeed would still do so, judging by the effect produced when, in March, 1812, owing to a high tide blowing up Scot's Float Sluice, the sea flowed freely to Robertsbridge, 15 miles up the country, and the returning ebb, as it appears in evidence, so scoured the harbour that vessels drawing 16 feet

Q. 2044.

water could get up to the town.

Landed interest, however, again prevailed, and in the following year the sluice was re-built. In 1830, a jury at Croydon found "that Scot's Float Sluice, as then erected, was a nuisance," and alterations in it were directed to be made;

Q. 2227.

these alterations not being made, it appears that the people assembled and pulled the sluice down.

An inquiry took place which led to the Acts of 1830 and 1833; under which one of the Rye Commissioners was named on the part of the Admiralty,

Q. 2200—12.

and we learn from his evidence, that since his appointment, an extensive creek, called the Nook, to the westward of the entrance, and covered every high water, has been in great part dammed out; and upwards of 700 acres of marsh land, lying on both sides the river, and overflowed by the sea to the depth of

Q. 2243.

3 feet, has been embanked, thereby losing the scour over the bar of 30 million cubic feet of water on every spring tide.

It appears, from the reports of engineers and others, that between the years 1724 and 1787, a sum of not less than 200,000*l.*, raised by a passing toll on shipping, was expended in vain attempts to form a new harbour about two miles to the westward of the present outlet to the sea, but which, after those 63 years' waste of time and money, they were compelled to abandon.

We have dwelt longer on this subject than at first sight it would seem to warrant, but the case of Rye is extremely instructive, as bringing broadly into view the apparently antagonist principles of the local and the shipping interests, and the absolute necessity of some controlling power to protect the

latter. There is a still more important consideration. Rye is situated on a part of the coast of Your Majesty's dominions, where a harbour is most wanted; and where it would be of the greatest benefit to our shipping, whether for steamers to obtain fuel in the event of hostilities, or, which is of far more consequence, for the safety of our merchant vessels in time of peace. And when we consider the capabilities it offers, the abundance of level land on either side of the river fit for docks or basins; the great value of a 23 feet rise of tide in the bay; and the extent of back water at command, we are led to believe that skilful engineering would readily turn these advantages to account for national benefit.

THE RIVERS FORTH, DEE, &c.

In addition to the examples we have given in detail, numerous instances of encroachments, of neglect, and of want of efficient control, have come before us in the course of our inquiries. For instance, on the banks of the Forth, near Stirling, large enclosures of marsh land have been formerly effected. Similar embankments, but to a much greater extent, have been carried out on the level lands by the side of the Dee, near Chester. At Whitby, we learn that it is a common practice to throw the refuse of the town behind the west pier head, which the next flood tide washes into the harbour. At Bridlington, great delay has occurred in completing the works for the improvement of the harbour, while a passing toll to pay for them is levied on all shipping. So unimportant, too, is this harbour considered, that a railway company recently inserted it in its schedule of property to be taken, amidst houses, fields, &c., without deeming the transfer of a public harbour of sufficient consequence to give it a clause in their Bill.

Q. 1805.

Engineer's Rep. App. p. 182.

Admiralty Survey. Rep. App. p. 179.

At the Spurn Point six vessels, of 50 tons each (paying 1*l.* a load to the Lord of the Manor), are daily engaged in carrying off the shingle from the beach, at the rate of 50,000 tons a-year, to mend the roads in Yorkshire and Lincolnshire. As it appears from the Report printed in the Appendix that the Spurn Point has lost half its breadth within the last 20 years, this removal of shingle may eventually endanger the lighthouses as well as the anchorage of Hawke Roads.

Admiralty Survey. Rep. App. p. 164.

At Portland, ballast is commonly thrown overboard with impunity. Similar complaints come from Fowey and from Falmouth; and with the addition from Milford Haven, that the water-bailiff remonstrates in vain, and has practically no power to enforce his commands.

We have the evidence of engineers, and of the Admiralty surveyor, that the Rivers Lune and Ribble, and Dee, are all susceptible of very great improvement; the Thames, even, the high road of the commerce of this great empire, for want of systematic conservancy and efficient dredging, has shoals with only 11 feet depth over them, even as low as Barking Reach, which prevent more than half the loaded vessels that come up to London from passing at low water spring tides; in short, there is hardly a harbour we have inquired into that, under efficient control, might not be in a much improved state.

Q. 1745—55.

We now proceed to the third head of our instructions, namely, to inquire into the state of the law as regards the subject under consideration, and we shall, on the present occasion, confine ourselves to a brief statement thereof.

The power, interest, and jurisdiction of Your Majesty extend in right of Your Majesty's Crown over all the seas and the shores thereof surrounding Your Majesty's dominions of Great Britain and Ireland; and in the same right Your Majesty has the property of the soil in all rivers which have the flux and reflux of the sea up to high-water mark of ordinary spring tides.

Magna Charta, c. 16 and c. 23, 25 Edw. III., c. 4.

Lord Hale, De Jure Maris, p. 17, and De Portubus Maris, p. 81.

Your Majesty's ancestors have from time immemorial exercised those powers, enjoyed the property and profits, and enforced that jurisdiction.

Chitty on Prerog. of Crown, p. 173.

The Lord High Admiral has, by prescription recognized by statute, the conservancy of the harbours and navigable rivers of Your Majesty's kingdom, and may inquire if any be guilty of any nuisance to such harbours and rivers.

Callis on Sewers.

If any nuisances were created in any harbour or navigable river the Lord High Admiral formerly caused the Attorney-General to file *ex officio* informations against the parties. They might also be pursued by indictment. But either remedy was dilatory and expensive. Parliament attempted to find

See 2 and 3 Will. IV., c. 71, s. 2, Williams *v.* Wilcox, 8 Ad. and El., p. 314.

Comyn's Digest, tit. Navigation.

Bacon's Abridgment, tit. Prerogative.

2 Blackstone's Commentaries, Stephen's Ed., p. 521.

Hawkins' Pleas of the Crown.

Sir Leoline Jenkins, pp. 76, 88, 96.

See Case of Isle of Ely, 10 Coke's Reports, 141.

Rex *v.* Smith, 2 Douglas' Reports, 411.

expeditious methods for preventing nuisances, and for removing any that might be erected, and passed the Act of 46 Geo. III., chap. 153, but it has been found wholly ineffectual to accomplish those objects.

Your Majesty's ancestors have by grants and charters given to certain bodies politic and corporate, the conservancies of certain harbours and rivers, and we find that the soil of the river Thames is claimed by the Corporation of the City of London, and that the soils of many navigable rivers are claimed by the owners of the lands on the banks thereof. Although a subject may by grant have the property of a navigable river, yet Your Majesty hath a right of empire or government over it in reference to the safety of the kingdom, and the people have a public interest of passage and repassage with their goods, and must not be obstructed by nuisances or impeached by exactions, for the *jus privatum* of the owner is charged with and subject to the *jus publicum* belonging to Your Majesty's subjects in the same manner as the soil of a highway is, which, though in point of property it may be a man's freehold, is nevertheless charged with a public interest of the people.

The Houses of Parliament have passed many Acts entrusting the conservancy of harbours and navigable rivers to certain Commissioners with large powers for that purpose.

Thus the jurisdiction of the Admiralty has by charters and Acts of Parliament been superseded, to the great detriment of the public service.

Having thus briefly recited the present state of the law with respect to the conservancy of our harbours and rivers, adduced a few examples of the want of efficient control in all our ports, and shown the necessity of immediate legislative measures in order to stop the daily increasing evils to navigation, we humbly take leave to lay before Your Majesty the recommendations which appear to us best calculated to meet the cases in question.

Your Commission therefore humbly recommend :—

That a Board of Conservancy be established for the superintendence and protection of all the tidal harbours and navigable rivers in the United Kingdom of Great Britain and Ireland; that it be in connexion with the Admiralty; and that it be permanent.

That this Board have jurisdiction by summary proceedings over the waters of the tidal harbours and navigable rivers, notwithstanding any Charters or Acts of Parliament to the contrary, with a reservation of private rights under the charters, and the continuation of local Commissioners where the Board may think fit.

That the Board should have full powers, by the assistance of engineers, surveyors, and others, to ascertain the extent of all nuisances and obstructions in tidal harbours and navigable rivers.

That the Board should be enabled to have a jury summoned by the sheriff to ascertain whether or not any encroachment or other nuisance in a tidal harbour or navigable river, has existed years; and if it be found to have been made within that time, that the Board have power by their own order, at the expense of the party who made such encroachment or nuisance, to remove it.

That the whole of the coasts of the United Kingdom be divided by this Board into districts, and that each be placed under the superintendence of a competent person, who shall visit each river, port, harbour, and creek at least once a year, or oftener, as it may be necessary, to inquire into and report on the state of each river, port, harbour, and creek in his district, and of all works which may be in progress there.

That the Board should have power to enforce the appointment of a resident engineer or harbour-master, or both, at every port they may consider of sufficient importance to require such constant superintendence.

That every Commission or Trust of a harbour or navigable river, or if there be none, every resident engineer or harbour-master be required to make out and forward to the Board before the 1st of March in each year, a detailed report made up to the 31st December, consisting of an account of all such works as have been executed, with the expenses thereof, within the limits of his super-

intendence, during the past year; and a report on those works he would recommend to be undertaken during the ensuing year. And, also, to include in that report an account of all changes that may have taken place during the year in the depth of water, or formation of shoals, or any other change affecting the navigation of the river or harbour.

That if any works, public or private, shall be commenced or proceeded with on grounds within the high-water mark of ordinary spring-tides, without having first obtained the sanction of the Board, or their superintending Officer, it shall be lawful, and the Board should be empowered immediately to stop such works, and to direct the removal of the same by the parties erecting them, and if they refuse so to do, the Board may direct their removal, and charge the parties with the expenses.

That for the protection of the public interests in the navigation of every river, port, harbour, and creek of the United Kingdom, a clause be inserted in every future Act, Charter, or Commission, which affects in any way the tidal harbours and navigable rivers of the country, giving power to, and requiring the Admiralty to appoint one-third part of the whole number of Commissioners to execute the trusts under such Acts, Charters, and Commissions, and also to have the power to change the whole or any of such third part of Commissioners from time to time, as the Admiralty shall think fit, so as to secure at all times a sufficient number at each board or meeting of the Trust, to protect the public interests against any bias or local interests.

That the Lords Commissioners of the Admiralty should direct the surveying officers employed in the seas of the United Kingdom to transmit to them, for the information of the Board of Conservancy, a list of all the parts of the coast on which they have been engaged surveying, and the harbours, ports, creeks, and navigable rivers they have examined, and on which they feel competent to give an opinion, in case of any improvements or alterations being proposed: also, that in future, in every port they visit, they shall make inquiries relative to any embankments or encroachments on the harbour or river, and generally as to any neglect in the preservation of the ports; and forthwith shall report the same to the Secretary of the Admiralty for the information of the said Board.

That, hereafter, the number of Commissioners or Trustees of any harbour or navigable river, docks, or other work affecting navigation, shall not exceed twelve (12), and that four (4) be a quorum, with a view to greater responsibility and the more effectual performance of the duties connected with such Commission or Trust.

That to all existing Harbour Commissions or Trusts the Admiralty shall have power to add new Commissioners or Trustees, not exceeding in number one fourth of the whole Commission.

That the Board should have power to call upon every such Commission, or Trust, or Harbour Master, as the case may be, to make out a correct account of all receipts of money by the said Commission in the course of the year up to the 31st of December; and from what source, and under what authority received; stating, also, the expenditure during the year under separate heads, so as to afford a current account of the resources of each Trust, and of the application of the same; which, after being duly audited, shall be transmitted to the Board of Conservancy on or before the 1st March following.

That the Board should have power to order that a tide scale be placed in all harbours; and in certain ports that a self-registering tide gauge be erected, accompanied by a barometer, and that a record of these be strictly kept; as well as a journal of the winds and weather; of the arrivals and sailings, of cases of wreck, or of any thing affecting the interests of navigation, and transmitted periodically to the Board of Conservancy.

That in all suits and proceedings at law, by the Directors or Commissioners acting under any Commission or Trust of a harbour or navigable river, it shall be imperative on them to take the opinion of, and to act under the directions of the law officers of the Crown.

That a summary of the proceedings of this Board be laid before Parliament on or before the 25th March in each year.

That an annual grant be made by Parliament for the support of the said Board.

Among the last recommendations which we humbly take leave to lay before Your Majesty, there is one which appears to your Commission of essential importance towards the improvement of our harbours, namely, the procuring accurate plans and surveys on a sufficient scale of all the ports and navigable rivers of the United Kingdom; not only for the present value of such plans as showing the actual state of the port, and as affording the basis for improvements; but also to be preserved as documents for reference hereafter, in order to determine at any future time what changes may have taken place.

For farther explanation of various points only briefly touched upon in this Report, we beg to refer to the plans and evidence, and especially to the opinions of the eminent engineers whom we have examined; and also to the various documents contained in the Appendix. Among the latter will be found the opinion of the Commissioners of the Navy, who having to inquire in 1818 into the state of the river Medway, even at that time strongly urged the necessity of a district superintendence along the whole coast of the United Kingdom similar to that we have now ventured to recommend to Your Majesty.

We beg to state that we are proceeding in our inquiry into the important matters submitted to our consideration, and that we shall hereafter submit a farther Report to Your Majesty.

Your Commission cannot close their Report without expressing, in the strongest terms, their conviction that immediate measures for detailed inquiry and local examination into the state and condition of every port and navigable river of the United Kingdom, are indispensably necessary, with a view to that thorough superintendence, without which many of the evils already recited are liable to recur.

And when they consider the great want of accessible harbours along the whole of the coasts of Your Majesty's dominions,—more especially when the extended use of steam navigation points to such great changes in maritime affairs, whereby every sheltered creek is likely to become of value—and when they consider that by the improvement of our tidal harbours Your Majesty's beneficent intentions for the preservation of the lives and property of a large class of Your Majesty's subjects may be best fulfilled, they earnestly trust that no minor consideration may be allowed to impede the accomplishment of objects of such national importance.

All which we humbly certify to Your Majesty.

WM. BOWLES, Rear-Admiral, M.P., *Chairman*.
J. J. GORDON BREMER, Captain R.N.
JOSEPH HUME, M.P.
AARON CHAPMAN, M.P.
EDWARD R. RICE, M.P.
THOMAS BARING, M.P.
F. BEAUFORT, Hydrographer.
G. B. AIRY, Astronomer Royal.
JOHN WASHINGTON, Captain R.N.
RICHARD GODSON, Q.C. & M.P., Counsel to the Admiralty.

London, 8th July, 1845.

MINUTES OF EVIDENCE.

LIST OF WITNESSES.

1845.

30th April.

Page

Mr. *William Bald*, C. E. 1

2nd May.

Mr. *Alan Stevenson*, C. E. 13

7th May.

Mr. *William Bald*, C. E. 21

The *Lord Provost of Glasgow*, Mr. *Charles Gray*, Mr. *Angus Turner*, Mr. *James Walker*, C. E. . . . 24

Mr *Richard Hinde*, Mr. *William Robinson*, of Lancaster. 33

9th May.

Mr. *William Robinson* 34

Mr. *Edmund Sharpe*, of Lancaster . 34

Mr. *John Swift*, Solicitor 38

Mr. *J. E. Errington*, C. E. . . . 38

21st May.

Captain H. M. Denham, R. N. . . 40

Mr. *John Macdonald* 45

Mr. *James Leslie*, C. E. 45

23rd May.

Mr. *Patrick Stead*, of Halesworth . . 50

Lieutenant F. W. Ellis, R. N. . . . 50

28th May.

Mr. *Patrick Stead* 56

Mr. *William Catt* 60

William Blandon, Wherryman . . 61

Lieutenant F. W. Ellis, R. N. . . . 62

Mr. *George Stephenson*, C. E. . . . 68

30th May.

The *Lord Advocate of Scotland* . . 70

Captain H. M. Denham, R. N. . . 73

The *Earl of Lonsdale* 77

Mr. *J. Leslie*, C. E. 78

4th June.

Page

Mr. *Adam Burnes*, Solicitor . . . 82

Mr. *David Stevenson*, C. E. . . . 84

6th June.

Mr. *William Galbraith* 90

Mr. *James M. Rendel*, C. E. . . . 92

11th June.

Mr. *H. C. Chapman*, of Liverpool . . 98

Mr. *Charles Hicks*, Mr. *David Manser*, *Henry Stocks*, of Rye . . . 101

13th June.

Mr. *James Walker*, C. E. 109

Mr. *John Miller*, C. E. 110

27th June.

Captain E. Holland, R. N. . . . 111

Mr. *Daniel Mackain*, C. E. 113

2nd July.

Captain J. Fisher, R. N. 117

Mr. *William Cubitt*, C. E. . . . 124

Mr. *J. P. Fearon*, Solicitor . . . 129

Mr. *P. W. Barlow*, C. E. 129

9th July.

Mr. *John Scott Russell*, C. E. . . . 130

11th July.

Mr. *James Walker*, C. E. 133

Mr. *William English*, Contractor . . 138

MINUTES OF EVIDENCE

TAKEN BEFORE

THE COMMISSIONERS APPOINTED TO INQUIRE INTO THE STATE OF TIDAL HARBOURS.

Wednesday, 30th April, 1845.

Present:—

Capt. Sir GORDON BREMER, R.N., in the Chair.

Mr. HUME, M.P.	Capt. BEAUFORT, R.N.
Mr. CHAPMAN, M.P.	Capt. WASHINGTON, R.N.
Mr. GODSON, M.P.	

William Bald, Esq., examined.

William Bald, Esq.

April 30, 1845.

1. (*Chairman.*) You are an engineer?—I am.

2. Are you acquainted with the river Clyde?—Yes, I have been acquainted with it since the year 1803, but I was appointed resident engineer and superintendent of the river Clyde under the Clyde trustees in the year 1839.

3. Will you state what has been done in improving the river since the year 1803?—I cannot say that I was particularly acquainted with the navigation of the river from 1803 to 1839. I had merely sailed up and down it. I was not professionally employed to examine it. My connection with the river only commenced in 1839.

4. From 1839 onwards, have you devoted your attention wholly and entirely to that river?—Wholly and entirely. My duties consisted in superintending the whole of the engineering operations of the harbour and river, examining all the accounts, writing out all the reports, and attending all the meetings. In 1839 the greatest barrier that existed to the navigation of the river Clyde was a bank near Port Glasgow called The Port Glasgow Bank; the depth of water there at that period was from five to six feet at extreme low spring tides; the length across the bank was about 700 yards. There was a cut commenced through it in 1841 and 1842, 300 feet wide, and the depth at present is from 10 to 10 feet 6 inches at low water spring tides, being an increase of from 5 to 5 feet 6 inches. At the time of high water high spring tides there is about 22 feet of water.

5. (Mr. *Hume.*) What was there before the cut was made?—Between 15 and 16 feet, being an increase of about 6 feet.

6. How was the cut made?—The cut was made by three dredge-boats, one of which had a 16 horse power engine, a 20 horse power engine, and the other 22.

7. Did you make a report upon that matter?—There was a report made.

8. Have you any minute of the date of that report?—No, I have not.

9. On taking charge of the river, did you report what in your opinion ought to be done with a view to improve the navigation of the river?—Yes; that was my first report.

10. Did you afterwards report what you had done?—Yes, I reported upon being appointed engineer for the improving of the river in 1839; that report was printed. There was also a second report printed, which I have not here.

11. What was the date of that report?—I do not remember; it was about 18 months after the first report.

12. Was the manner in which the operation was carried on of cutting the bank detailed in that last report of yours?—It was.

13. What did you do with the material?—It was laid on the shore of one of the small bays.

14. On the main land?—Yes, on the south shore.

15. Was it sand or shingle?—It consisted of the exuviæ and decomposition of oyster shells, and cockle shells, and mud.

16. Did you lay it above high-water line?—No; it was laid in a small bay on the shore side.

17. Why was it not placed above high-water mark?—We could not get ground there to deposit it upon.

18. Have you had those dredging machines in operation since on the same bank?—We were two years upon the bank with them.

19. In the two last years, has nothing been done towards removing the bank?—No, nothing more was required, the channel through it was deep enough.

20. State any other operations that have taken place?—The next bank that was cut through was the Puddle-deep Bank, about two miles higher up. I should observe, that the channel cut through the Port Glasgow Bank has not shown any tendency to silt up; it has been sounded since.

21. What breadth of channel did you cut through it?—Three hundred feet. After the Garmoyle bank was cut through, there was another bank opposite Dumbarton Castle cut through.

22. By the same means?—Yes, by the dredging-boats.

William Bald, Esq.

April 30, 1845.

23. What increased depth of water did you gain on that?—We gained about 2 feet or 2 feet 6 inches; it was deepened to 10 feet at low water. We generally dredge to 10 feet deep at low water; that is our rule.

24. And you maintain 10 feet at low water on the Port Glasgow Bank?—A little more. We have a greater rise of tide in the lower part of the river than we have in the upper reaches of the river.

25. Have you made any observations of the rise of the tide during the period you have been in charge of the river?—Yes.

26. In what way have you made those observations?—By tide staffs, and observations were made night and day.

27. In what way and to whom have you reported your observations?—The result of my observations were placed by me as records in the office.

28. Have you got copies of them with you?—No; the copies are lodged in the office in manuscript. There is an engraved copper plate, and it is on printed sheets taken from that plate that the tides are delineated. *(See rise of tides and velocity of water in Clyde, Appendix, No. 3.)*

29. Can you state what the depth of the water was at Glasgow Quay in 1839, when you took charge, and what the depth now is?—I should say that it was about 14 to 15 feet at high water neap tides in 1839; and now vessels drawing 17 feet of water can come up. From 2 feet to two feet six inches is the additional depth in the harbour.

30. Are you able to state by what means that depth has been increased?—By the dredging power alone.

31. In how many places has that dredging power been applied?—Over the whole surface of the harbour up to the bridge. The parts near the bridge have been 14 and 15 feet deep at high water of the low neaps in the autumn, and in the spring of the year at low water the banks were seen, so rapidly the harbour fills.

32. What other impediments to the navigation have you removed besides those banks?—The next cutting was at Dumbarton Bank; and a shoal at the head of the Long Dyke.

33. What was the nature of the impediment there?—It was a shoal.

34. What depth was there upon it?—I should think about 13 to 14 feet at high water low neaps, and there were other banks also cut through.

35. You have stated that you removed various impediments in the river, what were they—were they principally jetties, or rocks, or piers in the course of the navigation?—There were two jetties partly removed below Erskine Ferry, and above it a parallel dyke on the south side, near 500 yards long; and another parallel dyke was removed on the north side below the Newshot Isle, and a vast quantity of stone boulders removed from the bottom of the channel by two diving bells.

36. Did you lay down any rule as to the breadth which should remain, and the removal of all projections within that breadth?—Yes.

37. What were the rules that you laid down for your guidance?—To preserve a width of 300 feet at the mouth of Glasgow Harbour, and 310 feet at Kelvin River.

38. How far down is that?—1800 yards.

39. That is at the west end of the town of Glasgow?—Yes; and lower down it was to be 322 feet wide, that is 5 miles from Glasgow; and at the mouth of the Cart it was to be 400 feet wide.

40. How many miles is it from the Kelvin to the Cart?—The Cart is about 6 miles below Glasgow.

41. Is there any other alteration as you go down?—Yes, at the west end of the Newshot Isle it was to be 405 feet wide.

42. At Newshot Isle you appear to have taken the channel on the north side of the river, whilst to the south the channel appears not only wider but more direct; why did not you apply the dredge to the south side of the island?—The existing navigation is upon the north channel; the south channel is by far the best channel, there can be no question upon it, but the Trustees were not desirous of interfering with the south channel; they said there was some rock there that prevented them taking that direction.

43. Did you examine to ascertain whether there was any rock?—Yes, I was furnished with a section and borings, and I found that the expense of making that channel would be about 7000*l.*

44. If you had expended 7000*l.*, could you have made the channel straight instead of the circuitous one you now have at the north of the Newshot Island?—Quite easily.

45. Did you make any report to the trustees upon the subject?—I did not make a report to them upon it; I was not ordered by them to do so. I wrote a letter to Mr. Walker about opening it in 1839. *(See Appendix, No. 4.)*

46. Did you recommend that that should be done?—I did in the report laid before the General Trust, in January, 1841, in relation to the channel. It is in these terms:—"My Lord and Gentlemen, before closing this report, I consider it my duty to bring under your consideration the following subject. The Newshot Isle, bounded on the north by the present channel of the Clyde, and on the south by the old channel; the latter is quite straight and direct in its course, and is more than 100 yards shorter than the north channel, through which all vessels now pass in navigating the river; the south channel of the Clyde at the Newshot Isle is 2000 yards long, and contains an area of 486,000 square yards, or about 100 acres of water space, being nearly equal to the area of all the docks in Liverpool. This channel, if cleared out, will hold 34 millions of cubic feet of water. I have to announce that this great and valuable water space is rapidly filling up; and this channel of 100 acres of water, through which vessels formerly sailed will soon become fine meadow land, because both the lower and upper entrances of this channel have been nearly dyked up. My object in laying this matter before you is not for

the purpose of asking you to embark in executing one of the greatest improvements which is capable of being effected on the whole or any part of the River Clyde as to the directness of the course and line of navigation, and also in attaining an earlier and quicker, and an increased tidal flow upwards; no, I only beg that this valuable channel or sheet of water, containing 100 acres, shall not be allowed to silt up, and become fine meadow land, but that it shall be preserved for navigable and commercial purposes."

47. Was that Report printed?—No, it was not.

48. There appears to be a jetty on the west of the Newshot Island, opposite the property of Mr. John Henderson; at what time was that jetty made?—If it be a jetty, it was made after Mr. Golborne's Report in 1768.

49. How many feet does that jetty project?—450 feet.

50. Is it a solid jetty?—It is quite solid, and consists of earth and stone. It is a pier belonging to Mr. Henderson, of Park.

51. Does not that pier completely fill up the space between the island and the south channel, which would be the direct, and, as you think, the best channel?—It does to some extent.

52. Did you propose to remove any other jetties from the banks of the river?—I proposed to cut a piece off the point of that pier, and to remove all those jetties that lie in the way.

53. By which means you would obtain a straight channel for the tide?—Yes.

54. How did you intend to carry into effect the removing the piece south of the island to which you have referred?—By cutting away the point of the pier, and then removing the parallel dyke.

55. Does that dyke run parallel to the south shore, or parallel to the north shore?—More parallel to the north shore.

56. Was the south channel always the old channel?—In the recollection of several people, vessels passed up and down the south channel.

57. Are we to understand that your object was to re-open that straight wide passage for the navigation instead of the narrow and circular one to the north?—Quite so.

58. Since the representation which you made to the Clyde Trustees, has that channel continued to silt up?—Yes; I was ordered by the trustees to desist from taking away the stones on the parallel dyke. I had a remit or order from the trustees upon that subject.

59. Does this map show, that, from the point of the jetty projecting from the south side, a bank of stones has been thrown to the eastward till it joins the west part of the isle?—Yes; there is now a solid dyke of stones.

60. By which means the tide is prevented running up?—Yes.

61. Taking into account the expenditure of seven or eight thousand pounds, which you consider would be necessary to open the south channel, what would be the value of that channel as compared with the other?—I think it would be the greatest improvement that could be effected in the river.

62. Would the flow of the tide then be straight, and in a continued line?—Yes.

63. Instead of being in a line circuitous to the north?—Yes; measuring the velocity of the tidal-wave. It is found to run from Port Glasgow up to Bowling about 13 miles per hour; and from Bowling, on account of the channel being so crooked up to Clyde Bank, the run of the wave is not more than about 6·40 miles.

64. Do you consider that that decrease of the flow of the tide is owing to the channel going in that circle round the north of the island?—There can be no doubt of it; for this reason,—that again from Clyde Bank up to Glasgow the tidal wave runs at the rate of 10 miles an hour; it increases after it has passed the curvature.

65. (*Capt. Washington.*) Are you not aware that there are other circumstances than curvature, such as depth of channel above or below the place, which may influence the velocity of the tide?—No doubt the tidal wave will be quicker in the deep channel; but I think that the diminution in the velocity to 6·40 miles between Bowling and Clyde Bank arises from the crooked channel round Newshot Isle.

66. Is the channel the same depth all the way?—Nearly the same depth all the way.

67. Are you aware of any other impediment which would prevent the flow of the tide except that curvature?—I am not aware of anything else; and I was so impressed with this, that a paper was read by me before the British Association on the tides and the improvement of that part of the river.

68. (Mr. *Hume.*) At what date?—At the Glasgow meeting in 1840.

69. Do you give the accurate details in that paper from your experiments?—Yes I do.

70. Will you read the order which the trustees gave you to desist from removing the dyke?—In 1842 I began to take away the parallel dyke; I did that of my own authority, and I received this remit from the Committee 27th of July, 1842. "The committee of management of the Clyde trustees being assembled, there was laid before the Committee the following letter from Mr. Henderson (here it is quoted, it is in the minute of the trustees), which letter having been considered, the Committee direct Mr. Bald to discontinue the operations complained of, and to have a conference with Mr. Henderson on the subject, so as to satisfy him that no injury will be done to his quay, preserving always the rights of the trustees under the statute. Extracted from the minutes of the trustees, John Macfarlane."

71. Did you have any conference with Mr. Henderson?—No, nothing definite; I could make nothing of Mr. Henderson. This was in 1842. Considering it of so much importance to open this channel, I again, under my own authority, began to remove this dyke in 1843, and we took about twenty punt loads of stones from it, when Mr. Henderson addressed this letter to me. "Glasgow, 18th August, 1843. Dear Sir,—I beg to prefix a copy of a letter which I have this day sent to the river trustees, and to which I refer you. I hope you will feel it your duty to desist from further operations on the dyke until the trustees have considered my communication.

William Bald, Esq.

April 30, 1845.

If you do resolve to proceed, I hope you will at once say so, that I may protect myself by an interdict. Yours truly, John Henderson." Addressed to William Bald, Esq.

72. Did you begin on the dyke parallel with the river, or on the jetty?—On the dyke parallel with the river; I did not wish at that time to meddle with his quay, but only to get the dyke away.

73. Where did you begin your operations?—Near the middle.

74. Is not that dyke almost in the centre of the river?—It is nearly in the centre of the river between the north and south shores; it is a little more to the north.

75. Do you understand from that letter that Mr. Henderson claims his property to the centre of the river?—I do not consider that the dyke is his property, nor do I consider that the part coloured blue is his property; it is the surface of the river.

76. Did you begin to take down part of the dyke in the centre of the stream?—Yes, in order to keep the channel clear to preserve the depth.

77. What followed upon that letter?—I received a remit, which I hold in my hand. "At Glasgow, 25th day of August, 1843. The committee of management of the Clyde trustees being assembled there, was presented a letter from Mr. Henderson of Park, complaining of the removal of some stones from the dykes opposite to the lands of Park, which letter having been considered, the Committee direct Mr. Bald to discontinue any further removal of stones from these dykes, and an answer to be returned that instructions have been given to the said effect. Extracted from the minutes of the trustees by John Macffarlane."

78. (*Capt. Washington.*) Can you tell us when and by whom the dyke was formed?—By the Clyde trustees. I believe the late John Rennie, Esq. laid down the designs for the parallel dykes of the Clyde; but I found the designs of that able engineer had not been carried correctly into execution. For example, in one of his Reports on the improvement of the Clyde, dated 27th December, 1807, he states that the Clyde should be at Dunglass Castle 536 feet wide. Now between Dunglass Castle and the existing parallel dyke it is only now about 400 feet wide, and which is and has been highly injurious to the tidal flow and the navigation, and should have been widened even more than Mr. Rennie had recommended.

79. Are there minutes in the books of the Clyde trustees, giving to Mr. Henderson the land on the south side?—I rather think not.

80. Is there not a report by Mr. John Rennie at that time of his operations in the Clyde?—There is.

81. Do you understand that those dykes, at the time they were made, were made under the impression that they would improve the navigation of the river?—Yes.

82. (Mr. *Hume.*) But in your opinion those dykes so constructed have injured, and continue to injure, the navigation?—I will not take upon myself to say they are all injurious, but I think the channel between the dykes was made too narrow; it should have been made much wider. The parallel dykes had a beneficial effect in deepening the Clyde, but in my opinion there has not been sufficient width preserved in the channel of the river to let the tide flow up and down, and particularly at Dunglass Castle, and shutting up the south channel at the Newshot Isle, &c.

83. With respect to jetties or piers advanced 450 feet from the southern shore, are you of opinion that parallel dykes so placed have been beneficial or injurious?—I should think them injurious.

84. At what level are the parallel dykes made?—Nearly to the level of high water.

85. Are you not of opinion that every impediment to the flow of the tide upwards is an injury to the navigation?—Quite so.

86. Then is not that dyke an impediment to the flow of the tide?—There is not the least doubt of it.

87. Why then do you hesitate to say that it is not injurious to the navigation?—At that particular point it is injurious to the navigation to have a dyke across the mouth of such a channel, but in other parts of the river I think it is beneficial to have parallel dykes.

88. You have stated that in two successive years you began to pull this dyke down without orders and against orders; if you did so, what was the object you had in view—was it not to improve the navigation?—Yes, it was to let more water flow up into the river by taking away that obstruction.

89. Are those dykes at right angles with the course of the river, or do they run parallel with the current?—They run parallel with the current, and the jetties are generally at right angles to it.

90. If those dykes and those jetties are allowed to remain, is it not your opinion that this channel south of Newshot Island will soon be silted up?—Yes, I think so; the reason why I stated that in the Report was, that unless I had done so, hereafter the trustees might say, "You have been on the River Clyde for 20 years or 15 years; did you ever make an attempt to open up the south channel of the Newshot Island, in order to let up more tidal water; have you ever exerted yourself to prevent it becoming green ground?" and that was the reason I was so anxious to do what I did.

91. In what other places did you remove impediments?—I removed the weir at Glasgow Bridge, but that was under the authority of the trustees.

92. What was the height of that weir?—There might have been from three to four feet water on the top of it at high water.

93. What was the height of the weir at low water?—Three to four feet.

94. Has the removal of that weir in your opinion been productive of any benefit to the navigation?—Only so far as to let a little more tidal water up to Stockwell-street Bridge, but it has been most valuable in affording harbour accommodation to the small craft and timber rafts, and which accommodation should be extended up to near Stockwell Bridge, and which is much required.

95. At Stockwell-street Bridge is there any impediment to the flow of the tide upwards?—A very serious impediment.

96. What is the nature of that impediment?—It is the weir that has been made across the bed of the river to protect the foundation of Stockwell Bridge.

97. At what time was that made?—That bridge has been in existence for 500 years.

98. Is it your opinion that that weir stops the flow upwards to any considerable extent?—To a very considerable extent.

99. Beyond that, would there be any other impediments if that weir were removed?—There is a small shoal of sand and shingle at Hutchinson's Bridge, a little higher up.

100. Have your dredging boats been employed above any of the bridges?—Yes, above Glasgow Bridge, between Glasgow Bridge and the Wooden Bridge.

101. What depth of water have you gained there?—About four or five feet additional depth of water, but it is only upon a small portion between Glasgow Bridge and the Wooden Bridge; the whole should be deepened up to near Stockwell Bridge.

102. (*Capt. Washington.*) What do you consider the highest flow of the tide up the river?—The highest flow of the tide extends above the Glasgow Waterworks, and which is four miles and a quarter above Glasgow Bridge, at the point marked upon that plan; the ordinary tides only reach Dalmarnock.

103. (Mr. *Hume.*) Between Glasgow Bridge and the point that high water reaches, what other impediments exist?—I know of none.

104. Then if the weir at Stockwell-street Bridge was removed, do you consider that any great increase of water would flow up?—Yes, very considerable.

105. What would be the effect of that in deepening the water at the quays?—About from 20 to 30 millions of cubic feet of water would ascend up to about four miles above Glasgow Bridge, and that would have a very beneficial effect in scouring the deposition which flows into the Harbour of Glasgow from the common sewers of the city.

106. That shoal which you mention as being between the two bridges, if there was a free flood, would be swept away by that flood?—I think the current freshes of the river would sweep a great part of it away.

107. With the assistance of the dredging machines?—Yes; it is fine sand and gravel.

108. (*Capt. Washington.*) How high does the tide now go up beyond the bridge?—It goes up four miles and a quarter at very high tides above Glasgow Bridge.

109. How much higher would it go, if these weirs were removed?—I think something higher; I cannot tell how much higher.

110. Have you taken the levels in the higher part of the river?—Yes, we had the levels taken all up the river.

111. (Mr. *Hume.*) Are you able to furnish us with the levels of the river, in order to show what the depth of water was at the time when you took charge, and what it is now, and also to what extent it would go if those impediments were removed?—Yes, I can furnish those details.

112. If those impediments at Stockwell-street Bridge were removed, what would be the increased depth of water at Glasgow Quay?—I am not exactly prepared to say we should have an additional depth of water in the harbour, but we should have an additional scouring power of 20 or 30 millions of cubic feet of water ascending up into the higher reaches of the river, and that would have a beneficial effect in preventing the formation of banks and shoals in the whole river downwards.

113. Would not that of necessity deepen every portion of the river?—Yes, it would have an effect upon the banks and shoals down to Greenock.

114. Upon what data have you formed the calculation that from 20 to 30 millions of cubic feet of water would be obtained?—The calculation I have gone upon is this; the length of that part of the river line is 22,640 feet, the breadth is 214 feet, and the average rise of the tides taken at 6½ feet will give 31,492,240 cubic feet of tidal water.

115. Are the Commissioners to understand that that weir at Stockwell Bridge is the impediment to that increased flow, or are there any other impediments?—There are no other impediments that I know of, except the small shoal at Hutchison's Bridge, which I think would be scoured away by the currents if the weir at Stockwell Bridge were removed.

116. In your opinion is that weir necessary to support the bridge?—At present it is absolutely necessary to support the bridge.

117. Is it not the intention to remove that bridge?—There is a bill now before Parliament to take down that bridge, and to build a new bridge.

118. (*Capt. Beaufort.*) How much water-way does that bridge take from the stream?—I have not the documents here which would enable me to say.

119. Is it considerable?—No; there is plenty of room for the water-way, the present old arches are amply wide for the flow of the water.

120. How many arches are there?—Six.

121. Are they thick piers?—Not very thick.

122. (*Capt. Washington.*) You have stated that you have gained an additional depth of between two and three feet at the quay, what observation have you made with respect to the difference in the high and low water levels?—In consequence of the cutting away of the bank at Port Glasgow and all the lower banks, the tides are now lower in the harbour of Glasgow than they were in 1839.

123. Is there any difference in the time of high water at the bridge?—The last time I tried it was by means of two chronometers, and it gave me 10 or 15 minutes sooner in the harbour than formerly.

124. And you have the water lower now than formerly?—Yes.

125. Consequently the scour that takes place is augmented by the increased flood as well as the increased ebb which you also have?—No doubt.

William Bald, Esq.
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April 30, 1845.

126. (Mr. *Hume.*) Are you aware on what authority that weir at Stockwell Bridge was erected?—When the weir at Glasgow Bridge was removed the Clyde Trustees were bound by Act of Parliament to sustain the level of ordinary low water above Stockwell Bridge for the Glasgow Water Company; and those works constructed for that purpose have been reported to amount to about 3000*l.*

127. Do those works belong to the Corporation or to any public body, or any private Company?—They are for the benefit of the Glasgow Waterworks Company.

128. Consequently the public, who have lost the benefit of the river, have not benefited by the profit of the Water Company?—No, except the additional space from Glasgow Bridge to Stockwell Bridge, when it shall have been all deepened.

129. (*Capt. Washington.*) Supposing you removed that weir, would not Glasgow lose its water entirely? Would not that removal entirely deprive Glasgow of fresh water?—No, the bed of the river might be secured at Dalmarnock Ford.

130. How much above Glasgow Bridge?—About three miles, that is at the point to where the ordinary tide now flows.

131. Would that have the effect of keeping up a quantity of water for the supply of Glasgow?—It would.

132. Where do all the chemical processes and manufactories that go on in Glasgow draw their water from?—Principally from the Glasgow Water Works. There are some manufacturing places that have their pipes laid into that part of the river between Stockwell Bridge and Rutherglen, but it would be easy for them to lower their pipes, and still supply themselves.

133. Pipes could be easily put down even if the weir were removed?—Yes.

134. But at present they draw clear Clyde water, do they not?—They draw the water such as it is.

135. If you allowed the tidal water to go up, and that kept the water of the river back, do not you think that those pipes would draw up that water, rendered impure by the filth of the town, into the manufactories?—It would, but only to the few places between Stockwell and Rutherglen.

136. (Mr. *Hume.*) Up to what point does the salt water come?—In the dry season of the year no salt water is to be found in the upper reaches of the Clyde. Water slightly salt has sometimes been perceptible at Renfrew, that is nearly 6 miles below the city.

137. Are the Commissioners then to understand that between the point which you point out as the spot from which water might be drawn for the supply of the city and for all other works, and the point where the water becomes salt there is a distance of 10 miles?—It is more than 10 miles; the waterworks lie principally above Dalmarnock, except the Cranston Works, which lie below it a little.

138. In the operations which you have carried on of dredging and emptying, what quantity of materials during the year have you taken out of the river?—About 300,000 cubic yards now annually; there has been taken out during the last six years from the bed of the Clyde about 1,481,050 cubic yards of stuff. *(See Appendix, No. 3.)*

139. Do you include in that the stuff taken out of the Port Glasgow Bank?—Yes. The Port Glasgow Bank and the other banks.

140. You have not meddled with the Cockle Bank?—No, that is a dry bank, and the other is never dry.

141. Is Cockle Bank dry?—It is every tide at low water.

142. What has been the effect on the navigation since that increased depth of water has been obtained as to the number of ships that formerly resorted to the towns of Port Glasgow and Greenock coming up to Glasgow?—The trade of the harbour has manifestly increased wonderfully within these few years. In consequence of the increased depth of water vessels of a larger description, East and West Indiamen, have all come up the river without any difficulty.

143. Have ships of a size, obliged formerly to unload at Greenock and Port Glasgow, been able in consequence of that improvement to take in and deliver their cargoes at the city of Glasgow?—Yes.

144. Are you able to state what proportion of the trade that would be?—No, that is in the harbour-master's department.

145. Is it your opinion that if all the impediments which now prevent the flow of the tide up to the spot which you point out as the high-water mark, 4¼ miles above the quay were removed, the water would be still further deepened so as to allow ships of any size employed in the foreign trade to come up to the quay at Glasgow?—Yes.

146. What is the depth of water at low-water mark?—I should say from 10 to 12 feet.

147. Then large ships would lie a-ground?—No, the bottom of the harbour of Glasgow is remarkably soft stuff, and they are almost water-borne; they lie on a soft bottom.

148. Is there any place on either side of the harbour at Glasgow adapted for wet docks, in which ships of a large size could lie afloat?—About 400 yards west of the bridge, on the south side, a basin or dock has been proposed. It is in the plan, consisting of about 6½ acres of water space capable of holding about 60 ships of 400 tons.

149. Have you ground sufficient for that basin?—Yes, we have; but to make it a floating basin there would be considerable engineering difficulties to be encountered on account of the porous nature of the strata. I apprehend that when the water would be locked in, it would sink and escape. The best thing that could be done would be to make it a tidal basin. It might be made 15 feet deep at low water; and it would be a most useful and valuable ship basin. It was recommended by the late eminent engineer, Mr. Rennie; it has also been recommended by Mr. Walker, and laid down in his plan of the Clyde. The rise of the tide in the harbour of Glasgow not being more, at an average, than from 6 feet 6 inches to 7 feet; it does not become altogether so necessary to have an impounded basin of water to float ships. But on the north side, on the lands of Stobcross, there is ground inviting for the construction of a wet dock or a tidal harbour.

William Bald, Esq.

April 30, 1845.

150. To whom does that land belong?—It has been purchased lately by a company of gentlemen, some of them river trustees.

151. For what purpose?—I do not know. This is a plan of a harbour which I designed and drew out in 1840, containing 60 acres of water surface opening into the river and proposing the extension of Argyle-street down to it.

152. Would that have admitted of docks such as you have alluded to, capable of holding ships of a large size?—Yes, it would have been ample for the purpose; and also for dry docks, which are much wanting.

153. What depth of water could you have?—Any depth that might be required—18 or 20 feet, or more if necessary, by excavation.

154. Is the soil better there than at the south?—Yes, but I do not say that it would be water tight.

155. Is there any mode by which a dock of that kind could be puddled as canals are puddled?—It could be done. The expense is the only thing, and also the risk.

156. What difficulty would there be in puddling the other side—the south side?—It could be puddled in the bottom and sides, but it would be attended with considerable expense.

157. (*Capt. Washington.*) Are the London or Liverpool Docks puddled?—I do not know; those at Dublin were puddled. The quay walls would require to be all piled in Glasgow Harbour, and also those which would be built round any new basins or docks.

158. (Mr. *Hume.*) Beyond those impediments which you have mentioned, are there any others which prevent the increased flow of water in the Clyde?—The river Clyde at present is too narrow. It should be widened, and all the points in the river between the harbour of Glasgow and the mouth of the Cart river should be cut off, which would greatly increase and improve the tidal flow, and also the navigation, and which is pressingly required by the shipping trade.

159. Have you not been employed for the last two years in cutting off those points?—During the last two years we have made an addition to the harbour of about $7\frac{1}{4}$ acres, and we have cut off the point on the north side from the Kelvin east; and plans and estimates have been made for cutting off the points at Over Newton, Fairfield, &c. &c., and plans have been made for cutting off various points lower down.

160. Are there any objections to that being carried out now?—None.

161. What has been done with all the materials which have been taken out from the bed of the river; have they been laid on the land, or have they been laid on the alveus of the river?—Partly on the land and partly in the bays or creeks of the alveus of the river.

162. Do you not consider it objectionable to lay the material on the alveus of the river?—Highly objectionable.

163. Why then was it done?—We had no other place to put it, except in upon the shore creeks of the river; in the upper part there was no material put down on the alveus of the river, only in the lower parts of the Clyde, where the water space was wider than required.

164. Then in deepening and clearing the river, you have laid out the materials taken out of the river on the alveus, even to the injury of the river?—To the injury of the tidal water to a small extent; but in doing so, I have generally filled up the little creeks or bays, straightened and improved the line of the river, so as to allow the tide to flow along the land without interruption.

165. But do not all those fillings take up from the area over which the tidal waters would flow, and does not that consequently prove an impediment to the flow of the water?—I do consider it highly injurious to any river to shut out even one inch of the tidal water. I think that no deposit should be made below high-water mark, but that it should all be laid beyond it, in every case, except in so far as cutting off projecting points, and filling up indents, so that the water flow freely up.

166. Are the Commissioners to understand that in many of these arrangements you have been obliged to yield to circumstances either from the orders of the Board, or from difficulties which you were unable to overcome?—Difficulties which I have been unable to overcome, on account of the immense expense.

167. As an engineer, if you had been allowed to exercise your own discretion, you would have removed the material beyond the alveus, or limits to which the high water would at any time have come?—I would have done so, but the trustees did not exercise any jurisdiction over me with regard to the deposition of the stuff; they allowed me to lay it where I best could, and did so in the least expensive way.

168. If the trustees left you free to act in the way you thought best, why did you not preserve the alveus?—The alveus were not filled up by this deposition, but generally speaking the creeks and little bays were filled up, in order to straighten and improve the line of the river.

169. Have you found any difficulty in carrying out the plans, which you, as an engineer, judged necessary to improve the river, from the interference of the trustees or any other parties?—I do not know of any interruptions that I have received beyond that which I have referred to.

170. Do you consider that the navigation of so important a river as the Clyde should be left to local powers, without a superintending control from an independent and superior authority?—I am clearly of opinion that such an important navigation as the Clyde should be placed under an independent control, and removed altogether away from local interests of every description and kind.

171. Of whom are the Clyde Commissioners now composed?—"The Lord Provost, 5 Bailies of the city, 1 Dean of Guild, 1 Dean Convener, 15 Members of the Town Council, 1 Chairman of the chamber of Commerce, 3 from the Merchants' House, 2 from the Trades' House, 2 from the Barony of the Gorbals, 1 Provost of Calton, 1 Provost of Anderston, in all 33 members."

172. Are not those gentlemen principally merchants, and persons interested in property on the banks of the harbour, and in the quays and other parts belonging to them?—The Clyde

William Bald, Esq.

April 30, 1845.

Trustees are interested, many of them, in railway and water-works, and they are merchants, and connected with land, &c. &c.

173. Have any instances occurred lately where propositions have been made to interfere with the quays against your opinion as an engineer?—Yes.

174. In what case?—The Union Railway Company wished to occupy 2000 yards—the whole of the north side of the Harbour of Glasgow, and to have coal steaths erected, and it was proposed that that Union Company should purchase the right from the Clyde trustees. I reported against it, as well as the Harbour Masters.

175. Have you copies of your report?—Yes; and I now hand in one printed.

176. What injury, in your opinion, would be done to the port by that measure?—I think it would materially interfere with the East and West India trade, and with the North American trade, and with the Harbour of Glasgow. It would convert the greater part of the north side of the harbour into a coal basin.

177. Is not the northern side of the harbour employed at present by the West India trade?—By the American trade, and by the merchant vessels from the East Indies, from China; they discharge their cargoes on the north side.

178. Would it interfere with the wharfs and warehouses where goods have been usually lodged from those vessels?—I think railways crossing the quays might materially interfere with the general traffic.

179. Was your objection limited to the quays, or was it connected with the navigation?—My objections were founded upon this; that I thought the quays belonging to the harbour should not be occupied by any Joint Stock Company, and that a Joint Stock Company should not have any right to any part of the water-way of the Harbour of Glasgow, or to the streets of the quays.

180. Has your recommendation been attended to?—No, I think not; I think the trustees determined themselves to lay rails upon the quays.

181. Which you consider will be an injury to the port?—I should certainly think that it would be to the general traffic to be crossing with goods from these railways; but stone tramways, level with the streets of the quays, might perhaps be found useful in carrying heavy machinery, &c.

182. You are not prepared to say that any injury to the navigation of the river would arise from it?—The Clyde trustees should not give any Joint Stock Company the power of putting down coal steaths for loading coals, and of occupying 1300 lineal feet of the harbour, it would be highly injurious to the American, East and West India trade in the Harbour of Glasgow. But a coal basin for the shipment of coal might be formed below the harbour.

183. Has one of your objects been to make the port of Glasgow the harbour for the foreign trade, which hitherto has been divided from the want of depth of water at Glasgow, between Glasgow and Greenock?—Yes.

184. What experience have you had in other tidal harbours and water communications?—I extended a pier at West Port for the Marquis of Sligo. I was also employed by the Board of Works to report upon the improvement of the navigation of the River Boyne, in Ireland, and the Port of Drogheda.

185. In what year?—In the year 1831 and 1832; that navigation and harbour remained under my charge for a period of six years, and received great improvements; I had a dredging boat there.

186. Did you carry out upon that river the same principle that you carried out on the Clyde?—Yes.

187. Were great benefits derived at the port by that means?—Yes.

188. Are there any accounts of the benefits derived from those operations on the Boyne?—Yes, they are with the Boyne Commissioners in Ireland.

189. Does your recollection serve you in what way the improvements to which you allude were beneficial?—The depth of water was considerably increased, and the trade of the port was also consequently increased. The plans of the improvements have been published by the House of Commons, connected with the public works of Ireland.

190. Did your plan of deepening the river, and removing impediments, receive the approbation of the Commissioners at the time?—Yes, here is a letter in which they state that they highly approved of the manner in which I had carried out the improvements.

191. Will you state what change took place which induced you to leave the Boyne?—I continued in the employment of the Boyne Commissioners as long as they required me, till the whole of their funds were expended; and the resident engineer, whom I had recommended there, Mr. Young, still remains with them carrying out the improvements, he having acted under me during a period of six years.

192. Have you been in communication with him since to know whether he has continued your plans of improvement?—I understand that the plan which I laid down is exactly the plan which he is now carrying out.

193. And that plan is the plan you have acted upon in the Clyde?—Yes, it is the same in principle.

194. From that where did you go to?—I laid out a plan for the improvement of the navigation of the River Moy in the west of Ireland. The plan passed both Houses of Parliament, but having left Ireland at that period to join the Clyde, I am not aware how far they have carried out the operations proposed.

195. What other experience have you had?—I planned a harbour in Tramore Bay in the south of Ireland; I also carried through in 1836 a plan for the improvement of the river Suir in the south of Ireland; I lately drew two plans for the improvement of the harbour of Troon, and the wet dock that is now being carried into execution.

196. Under your superintendence?—I am occasionally consulted; it is according to the

plans which I laid down; Captain Manyard occasionally consulted me about it. I was also consulted at Belfast when it was proposed to throw a dam across the river in order to make a still water harbour to the quay by shutting out the tide; my opinion was directly opposed to that, and that plan was given up, and the tide left to flow up to the town, as it now does; and that was carrying out the principle which I have since carried out in the Clyde. I fully agreed in the plan proposed by Mr. Walker at Belfast, of allowing free egress for the water. Last summer I got plans and sections and charts made for the improvement of the river Foyle at Londonderry in Ireland; it is a tidal river; those plans and sections and reports were sent over to the Commissioners for the improvement of that river. I have not heard whether they have carried them yet into execution or not.

197. Those plans were founded on the same principle of removing every obstacle to the flow of the tide?—Yes, cutting off the points of the river, cutting out the shoals, widening the river, and deepening it, and inviting a larger tidal flow up into the country; it is the principle I have universally acted upon.

198. Have you had any other experience?—I was employed by the Lord Provost and Town Council of Perth to defend the river Tay from the invasion made upon the tidal way by the Earl of Zetland two years ago. I gave my aid and advice to repel the invasion, and the Lord Provost and Town Council of Perth were successful in a law suit instituted for the removal of the obstacle.

199. Did not that obstacle consist in dykes thrown out similar to those which there are in the Clyde?—Yes.

200. And by the decree of the Court of Session the Earl of Zetland has been compelled to remove them?—Yes.

201. Were you examined as a witness on that trial?—Yes, and I bored the Tay and discovered that the very dyke works which the Earl of Zetland had constructed were upon a portion of the ancient channel of the Tay.

202. Do you mean that there were stones on the old soil?—There were stone works and embankments pushed out from the land upon the tidal way, shutting out the tide.

203. Did your evidence maintain that all such encroachments from either side tended to stop the flow of the tide towards Perth?—Yes, there is no question of it, they were injurious to the navigation.

204. Do not you attribute the great benefit derived in the navigation of the Clyde to the dredging?—I do; I consider that the great depth of water obtained in the River Clyde has been mostly from artificial means, and that principally by dredging; there are five dredging boats with steam-engines. The parallel dykes laid down by the late Mr. Rennie improved the navigation of the Clyde considerably; and some of the jetties laid down by Mr. Golborne were useful, and some injurious.

205. From your extensive experience have you found that local influences have very much interfered with that which is a national object, keeping rivers clear?—In every case I have found that to be so.

206. Is it your opinion that that department of the Government devolving on the Admiralty should be placed on a footing to enable the Admiralty to take cognizance of every encroachment of whatever kind within high-water mark, whether on sea-shores or other rivers?—That is my opinion decidedly, that it should be under the jurisdiction of the Admiralty; I would place under a superior authority every tidal harbour and every tidal river, and all invasions which are made upon the sea should be resisted wherever tidal harbours or tidal rivers were concerned.

207. In visiting those various places, have you been able to satisfy yourself that every encroachment that you have found has been injurious?—In every tidal river that I have examined, I have always found that wherever an encroachment has been made upon the sea, it has been injurious to the navigation for this reason—that it shuts out the tidal water, and hence it is a loss of the tidal scour necessary to preserve the navigation.

208. Have you found that the proprietors of land adjoining, and the proprietors of wharfs for their own individual interest, have thus encroached on what ought to be left a highway for the commercial navy of England?—I have; I am thoroughly convinced that there are injurious invasions making at this moment upon many of the tidal harbours and tidal rivers on the shores of Great Britain and Ireland.

209. Have you visited lately the Firth of Forth, opposite where an encroachment has been made of many hundred acres, and where an enclosure is now going on to a great extent?—I have heard of that, but I have not examined it; but I am aware that such a thing is going on, and also in the Bay of Belfast; where 2500 acres are proposed to be embanked; and in Lough Swilly there have been embankments made, and also in Lough Foyle. I believe the extent of the embankment proposed there amounts to not less than 20,000 acres, but I have not seen the plans.

210. Have you been on the spot?—I have been over part of Lough Foyle and Lough Swilly.

211. Have you been able to form any opinion as to the amount of injury that would arise?—I have warned the Commissioners of Londonderry, who are the conservators of the River Foyle, of the great danger that would result from the shutting out of the tidal waters. I have used the most emphatic language possible in my Report, with a view to impress upon them the necessity of endeavouring to oppose all such invasions of the tidal way. The Foyle is like a gulf; and by shutting out such a vast quantity of tidal water, the consequence will be, that the mouth of the harbour will become barred.

212. Have you any acquaintance with any harbours to the southward?—I have been lately in the Tyne; and there is a large lake, Jarrow, which they propose to embank in, but I think it would be highly injurious to that navigation if it were embanked, and I gave that as my opinion on the spot to several gentlemen.

William Bald, Esq.

April 30, 1845.

213. Is not that plan brought in by persons who are appointed as Commissioners to protect the navigation?—I believe it is.

214. Can you give any information as to the actual encroachments within the last 50 years on the Clyde?—Yes: the oldest map that I know of the Clyde is the one executed by Mr. William Kyle, of Glasgow, in 1800. This map exhibits 219 jetties, which jetties were commenced in 1768 by Mr. Golborne, the engineer. I consider those jetties to be valuable, in showing the extent of the ancient high-water mark of the river Clyde; because, by uncovering them, we may ascertain how far back the tide originally flowed at high water, and in that way the whole of the ancient alveus or border of the Clyde might be accurately laid down from a survey upon a map, and the extent of the invasion on the river ascertained.

215. Have the spaces on each side of those jetties,—that which was alveus before, become fine solid land?—They have become, to a great extent, fine solid arable and pasture land.

216. Consequently they have diminished the tidal flow to the extent of each encroachment?—No doubt of it.

217. Would any benefit be derived to the navigation by removing any portion of those jetties, if it should appear that they were not legally erected?—I think very great advantage would arise by increasing the tidal flow and improving the navigation.

218. What height did the tide rise over those alveuses?—I cannot say, but they were originally all covered by ordinary tides.

219. If those impediments narrowed the navigation, would they not strengthen the current so much there as to give a greater scouring power?—Yes; wherever a river is narrowed it will increase in depth, because the velocity of the water is increased: but then, on the other hand, the Clyde has been too much narrowed, and, consequently, its tidal flow has been greatly diminished. It might be greatly improved by opening it fully and properly up; and removing many of those parallel dykes, points, jetties, weirs, and other impediments and obstructions which now exist, to the great injury of the navigation; you would then have a greater tidal flow higher up, and, consequently, there would be less expense in dredging in the harbour of Glasgow, and less expense of dredging down along the river. At present, the deposit in the harbour at Glasgow amounts to about 80,000 cubic yards annually. At Bowling, 10 miles below the harbour of Glasgow, a bank annually rises, which requires to be dredged out, which I estimate at from 60 to 70,000 cubic yards. I calculate that, to keep the river Clyde clear at present, and the harbour at Glasgow, requires an annual dredging amounting to about from 160 to 180,000 cubic yards.

220. Would not that amount of deposit annually decrease in proportion to the increase of flow upwards?—Quite so; and it would lessen the expense of dredging.

221. Though a narrow channel quickens the current and deepens the passage of the water in the immediate place, does it not tend to stop the flow to the upper part of the river, and, consequently, injure that part though it may benefit the other part of the river?—No question through a narrow channel less water will flow up, and with a wider channel a greater quantity will flow up.

222. Then you are of opinion, that every impediment which stops the flow to the highest possible point to which the water can reach in the highest tide ought to be improved?—That is my opinion.

223. Every impediment to the effecting of that object is an injury to the navigation, interfering with it, and causing expense to keep it open?—No question of it.

224. What is the depth of the water in the North Newshot Isle Channel at low-water springs?—It runs generally from 9 to 10 feet; that is, on the north channel, the channel in which ships sail.

225. If you disused that channel, and allowed water to flow through the south channel, would not that north channel tend to fill up?—I think not; we would have two mouths, and we would have a greater quantity of water flowing up more quickly.

226. If your attention was directed to the dredging of the south channel and keeping it open, it would be of less importance whether the northern channel silted or not?—It would, because the southern channel being more direct, would form a much better navigation than the north channel, and much more inviting for the tidal flow of water upwards.

227. Then from your extensive experience do you recommend that an authority paramount to all local boards should be placed in the Admiralty, or some competent officer as conservator of the rivers and tidal harbours of the country?—I am clearly of that opinion; I do not think that either the interests of tidal harbours or of tidal river navigations ever will be attended to unless the whole are placed under a Board such as the Admiralty, acting immediately under the Crown; and I think that no local interest should have anything to do with the preservation of those great tidal rivers and tidal harbours,—that all local interests should be entirely excluded from their management.

228. Would your superintendence extend to every act of legislation in which navigation is in the least degree interested; would you extend your supervision to the watching of all navigations connected with every tidal harbour?—Yes, every tidal harbour and every estuary and tidal river, I would place the whole on the same footing that the Government of France have placed their highways; I would place them under the Admiralty, immediately acting under the Crown, and remove it entirely from all local authorities.

229. You have been in France?—I have; I resided four years in France.

230. Can you state what is the system on which the French Government act in respect to their harbours and navigable rivers?—The whole of the large tidal harbours and navigable rivers of France, so far as I understand, are placed immediately under the Government of France, and under their own engineers, in the same manner as the roads and bridges. The Breakwater and Basin at Cherbourg were executed by the Government engineers. The

improvement of the harbour of Dunkirk, one of the most extraordinary engineering schemes, and the most successful which had been executed in France, and which annoyed the trade of England to an enormous extent, was executed by the French Government. In 1706 it enjoyed a most flourishing trade, and during the war which terminated in the Peace of Utrecht, its privateers took 1,614 English ships, value 1,334,375*l*. At the treaty of Aix-la-Chapelle, England insisted upon the demolition of the harbour of Dunkirk, our trade and commerce having suffered so much.

231. Are you acquainted with St. Malo?—I have not been there since 1826.

232. Are you aware that there are some extraordinary works there?—Yes.

233. Do you think this system of superintendence in France, with respect to harbours, works well or ill?—I am not sufficiently acquainted with the local details to answer, but I have not the least doubt that such a thing, if done in Britain, would work remarkably well.

234. The Commissioners understand you to state that in France no local influences are allowed to interfere with the erection or the management of large harbours?—None.

235. The Government employ their own responsible engineers?—Yes, and take the whole management into their own hands.

236. Is it your opinion that in the erection of all harbours, and any improvement that may be proposed here in England, a Government engineer should be responsible that their execution does not interfere with the navigation?—I am decidedly of that opinion.

237. Do you consider that one engineer would be sufficient in Great Britain for the whole country, or would you propose one for England, one for Scotland, and one for Ireland?—I am not able to answer that question without much consideration.

238. Do you not consider that, in order to guard against future encroachments, some office under the Government ought to be possessed of minute plans of every harbour and creek in this country?—I consider that one of the most useful things that could be done by a maritime nation, would be to collect plans of all the harbours and ports. The wealth and strength of Great Britain depends upon her commerce; and accurate maps and plans of all the ports and harbours would be most valuable as regards their improvement and preservation.

239. You are aware that there have been propositions made to the Government to expend a very considerable sum in providing for harbours of refuge?—I am.

240. Do you not think it of equal or even more importance that the natural harbours of this country should be improved to the greatest possible extent?—I am clearly of that opinion.

241. Are you of opinion that the application of small sums of money requisite to carry out improvements where local means might be wanting, ought to be considered as a national object in this commercial country?—I think the Government should give every assistance possible to the improvement of the ports.

242. Do you not consider that that would be an economical application of the public money?—I am of that opinion, decidedly.

243. Have you been applied to on the part of any persons in France to go over there?—Yes. I have been applied to by the chairman of the Chamber of Commerce at Rouen, to examine the port of Havre-de-Grace, Honfleur, and the river Seine, but more particularly the improvement of the river Seine; and I propose going over there in a few days to examine those ports. I have received a letter from the chairman of the Chamber of Commerce upon the subject.

244. The letter states that at the mouth of the Seine there are banks of sand and other impediments which are injuring the harbour, and he wishes for your advice, with a view to its improvement?—Yes. I will give a copy of that letter and my answer, because it contains the principles upon which I have acted, and on which I think the improvement of tidal rivers and harbours should be conducted. (*Vide Appendix, No.* 4.)

245. (*Capt. Washington.*) With the opinions which you hold very strongly with respect to the improvement of tidal rivers, would you, were the Clyde now placed in your hands, with no impediments to the navigation, place parallel dykes or not?—I would, to a certain extent, place parallel dykes, but dykes differently designed and constructed altogether from those which now exist. I would erect half-tide and quarter-tide dyke-works. I would undo, to a large extent, much of the works which had formerly been done, and I should also change every single department connected with the operations of the river and harbour, and re-organize them upon a different basis.

246. Would not such dykes impede the flow of the tide?—They should be so constructed as not to impede the flow of the tide.

247. (Mr. *Hume.*) But why would you have any dykes at all?—It is necessary in soft soil like the Clyde to protect the banks and guard the channels by dykes or beach-works; it is at the last half ebb that the scouring power takes place generally in the Clyde, and it is then that the water would be confined within the limits of those parallel dykes and act upon the channel, and keep it clean.

248. Then should there be one continual line of half-tide dykes?—I would begin with quarter-tide dykes at the lowest part of the river, near the deep water or sea.

249. The height of those would be equal to a quarter tide?—Yes, and higher up the river I would place half-tide dykes, and in the highest parts dykes as high as high water.

250. In order to benefit by parallel dykes, must not the dykes be continued till you come down to the deep water?—They must.

251. If any interruption takes place in the dykes, will not the part where that interruption takes place be liable to silt up and form banks?—I have found so by experience.

252. You said that one object of making parallel dykes would be the protection of the banks in the upper part of the river; do you think it necessary for the scouring power?—No, not altogether necessary for the scouring power, but to prevent the banks of the river from being washed away. Wherever the dykes break down, the waves of the river wash out the alluvial stuff from the banks into the bed of the river and form banks and shoals.

William Bald, Esq.

April 30, 1845.

253. You would think it essential that the banks should not diminish the reservoir?—Most certainly.

254. (*Capt. Washington.*) You have stated that you think if all impediments were removed the greater power of the tidal water would keep Glasgow Harbour much deeper than it is at present; do you consider the depth of the water in the harbour due to the tidal waters or to the river freshes?—To neither one nor the other but to the dredging power. Land floods deposit large quantities of sand in the harbour.

255. How great is the rise in freshes in general?—Fifteen feet in the harbour in high floods above low water.

256. What is the greatest rise of the tide?—From 8 feet to 8 feet 6 in the harbour of Glasgow.

257. Is not Glasgow often flooded by great freshes?—Since 1839 I have not known it flooded.

258. Would not the removal of these impediments tend materially to the better drainage of the city of Glasgow?—Most unquestionably.

259. You are of opinion that the waterworks and factories depending upon the supply of water from the Clyde, as at present, can be maintained in other ways so as not to interfere with the removal of the impediments you are speaking of?—I think so.

260. Who has been the consulting engineer during the time you have been resident engineer at Glasgow?—Mr. James Walker. He made out the late Parliamentary plans.

261. Have your different proposals for the improvement of the river been submitted to him?—No, not the building of any quay-walls or works; but the Parliamentary plan of Mr. Walker, which is now on the table when it was passed, was found to be of so large and expensive a character, that I was directed by the Committee of Management to draw out a plan for the improvement of the river Clyde less expensive, which was approved of by the general trustees in July, 1841, which plan has been nearly the basis on which they have made their cuttings since, and those proposed.

262. Did not that plan embody the principles contained in Mr. Walker's plan?—It did.

263. Was that plan, so modified, submitted to Mr. Walker?—I do not think it was ever submitted to Mr. Walker to my knowledge.

264. (Mr. *Hume.*) Have you had occasion to consult him since upon any of your proceedings?—No. All the works which I have executed the plans have been drawn by myself, and executed by myself, without consulting any engineer whatever during the six years.

265. Then, from the time that you received your instructions, Mr. Walker has not been consulted by the authorities?—Mr. Walker was consulted; but not on the building of the quay walls, the timber wharfs, or the construction of Bowling Basin; the bridges are under the management of the trustees for building the Glasgow bridges. And he has been, I believe, consulted about laying rails on the quays of the harbour by the Clyde trustees.

266. Why are they obliged to take down Stockwell Bridge?—It has been alleged to be insecure.

267. Owing to what cause?—They have alleged that the deepening of the upper harbour endangered Stockwell bridge. But I deny that. None of the operations conducted under my superintendence have at all rendered Stockwell Bridge insecure, as it has been properly protected since by new works.

268. Do you propose any further operations that would endanger Stockwell Bridge?—I do not think that any deepening that may be required for the small craft would now endanger Stockwell Bridge. Mr. Walker has lately driven a close row of piles, immediately below the bridge, and also four rows of open piles, and above the bridge he has driven another row of close piles, so that the foundation of Stockwell Bridge has been completely shut in and protected; and I do think that Stockwell Bridge is perfectly secure at present.

269. Do you know any reason why the Clyde Navigation out of its funds should give any money towards that bridge?—I know of no reason except, for additional tidal water, the one alleged. By the removal of the weir to a point 140 yards above Hutchison's Bridge.

270. Would that be any injury, in your opinion, to the foundation of Stockwell Bridge?—None whatever, if a new bridge were built; but it would be a benefit to the harbour so far that there would be an additional flow of the tidal water up that length; but at the same time it would be attempting to legalize what I consider a very unlawful thing, namely, putting a weir across a tidal river, which I object to most decidedly as being highly injurious to the navigation.

271. Was that weir put across under any legal sanction?—No; but the Clyde trustees were bound by Act of Parliament to secure the bridge and the level of the water at Stockwell Bridge, when the old weir at Glasgow Bridge would be removed.

272. Therefore, as it was placed there without any legal sanction, it may be removed under the authority which exists for removing all impediments in navigable rivers?—I think so if a new bridge be built. The weirs upon the Shannon river in Ireland I think were removed where required.

273. And you consider that any appropriation of the funds of the Clyde to the erection of bridges is not warranted?—I think not, nor for any additional tidal water which might be obtained by deepening and improving the channel bed of the river Clyde.

274. The weir across was not erected by any public authority?—No; the original weir that existed at Glasgow Bridge was erected in consequence of the old bridge being in a state of danger from floods. On a Sunday they threw in an immense quantity of stones, it was in such imminent danger, and those stones remained there to support the foundation of Old Glasgow Bridge.

275. In what year was that?—I cannot say; it was before my time.

William Bald, Esq.
April 30, 1845.

275*. Then that weir existed till the New Glasgow Bridge was built?—Yes; but the weir was removed after the Clyde trustees got their last Act of Parliament up to Stockwell; previously to that there was no regular weir at Stockwell; there were stones across, to guard its foundation against the action of the floods; and when a new bridge has been proposed at Stockwell, it has been proposed to remove the weir 140 yards above Hutchison's Bridge.

276. *(Capt. Beaufort.)* With regard to the supply of the factories in Glasgow, if the water was taken from a higher part of the river, would there be any necessity for a weir at all?—There would not. It would be quite practicable to get water from a higher part of the Clyde by an open cut, and by that means they would get clear water.

277. Can you say how far they would have to go up the river?—About two miles and a-half.

278. By that means the navigation of the river would be clear for two miles and a-half up?—It would be cleared for nearly three miles up; it would produce a great increase of small shipping craft, the river would also become a valuable conveyance for coal and iron, from the higher country to the ships in the harbour of Glasgow, and small steamers might sail up from Glasgow Harbour to the town of Rutherglen, and downwards.

[*The Witness withdrew.*]

Adjourned till Friday at one o'clock.

Friday, 2nd May, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Mr. HUME, M.P.	Capt. BEAUFORT, R.N.
Mr. A. CHAPMAN, M.P.	Capt. WASHINGTON, R.N.
Mr. GODSON, M.P.	

A. Stevenson, Esq.
May 2, 1845.

Alan Stevenson, Esq., examined.

280. (Mr. *Hume.*) You are engineer to the Northern Lights?—I am.

281. How long have you been acting as civil engineer?—Since 1829, more or less.

282. Have you directed your attention to tidal harbours and rivers?—I have.

283. Will you state what rivers you have viewed?—I have been connected with the Tay and the Forth in Scotland, and with the Ribble and the Lune in Lancashire, and the Dee in Cheshire.

284. Have you been employed professionally to view and to give opinions on the state of those rivers?—I have. I have acted along with my brother, and along with my father.

285. Have you found in all those rivers a disposition to silt up?—Yes; there has in most of them been a considerable fall in the bed of the river, which I attribute to the tendency to silt. I mean that the upper part has been shallower than the lower part; the fall in the bed has been greater than one would expect.

River Tay.

286. With regard to the Tay, will you state what have been the results of your observations there, as to encroachments on the navigation, and the measures that have been adopted to remove those encroachments?—I surveyed the Tay, in 1833, along with my brother, David Stevenson, engineer in Edinburgh, and at that time the principal obstructions to the navigations were at Kirwhinnel Ford at the top of Mugdrum Island, at the entrance of the River Earn, at Seggieden Ford, at Mill Hurst, and at several other fords.

287. What was the nature of those obstructions?—Most of the obstructions consisted of a hard band of gravel lying across the river, but it occurred at each of the islands in the river, and the channel was diverted into a double course opposite those islands immediately at the fords.

288. Those had been probably ancient fords before bridges were established?—Very probably they might. We found nothing, however, except some timber at Millhurst, to induce us to imagine that they were artificial.

289. Were there any other impediments on the side of the river?—Yes, down at Newburgh in particular.

290. In many places?—There were some 8 or 10 jetties thrown out.

291. To what extent were any of those jetties?—Some of them reached so far as to come into a depth of 8 or 10 feet at high water, and 200 feet within the tide mark.

292. How many feet was the longest?—On the opposite side of the river they were very long; about 200 feet was the length of Lord Dundas's longest jetty.

293. Forming a bank into the stream of 200 feet?—Yes.

294. Was it made throughout the whole of those 200 feet solid?—Solid throughout, of stone.

295. What was the immediate effect of that solid projection on the depth of the water of the river?—The effect was to produce a very large accumulation of gravel and mud chiefly on the upper side of the jetty.

296. Do you consider that that collection was formed by the impediment which the jetty gave to the free flux and reflux of the tide?—There can be no doubt of it, because in the case in which I was examined, in Perth, before the Jury Court, three years ago, for the purpose of removing those jetties—I mean the case of the magistrates of Perth against the Earl of Zetland—evidence was adduced to prove that where the jetties now are the navigable channel of the river existed before those jetties were erected.

A. Stevenson, Esq.
May 2, 1845.

297. What was the result of that trial?—The result of the trial was an order to remove the jetties in part only. We were obliged to content ourselves with the removal of only part. We could not get the whole removed.

298. How long had those jetties been established?—Some of them 20 years, and some of them came very nearly within the time of prescription, which is 40 years, but the great majority of them were not so old.

299. Did you submit to the Court the propriety of removing the whole of the jetties that were within high water mark?—Not to the Court, we were obliged to content ourselves with requiring less of the Court, in obedience to the opinion of the law adviser.

300. But in your opinion the navigation of the river would have been benefited by removing them entirely?—Yes.

301. Did your evidence go to that?—My evidence was confined solely to the question that was before the Court.

302. Has any portion of those jetties been removed?—Part has.

303. Have you had any opportunity of knowing what has been the effect consequent upon that removal?—There has not been sufficient time to see the effect of the removal yet, because the artificial fore-shore which they had created still exists; it has not been removed.

304. Therefore the collection formed by those jetties will require some time or artificial means to remove it?—In all probability artificial means.

305. In what other parts have you found encroachments?—Opposite the Earl of Wemys's property, at a place called Muirhead, a large jetty was extended; it went out, I think, 600 feet.

306. (*Capt. Washington.*) To low-water mark?—Yes; I am speaking from recollection of the length of it.

307. (Mr. *Hume.*) There appears to be an embankment extending from the river Earn, westward, do you allude to that?—No, the embankment does not exist now; it was removed upon a report being made. The Earl of Wemys acknowledged that he was bound to remove it; we required him to remove it, but it had begun to cause accumulation.

308. That jetty at Wemys has then been removed?—It has.

309. Is the embankment and accumulation of mud which was forming decreasing now?—Yes it did decrease, and it was partly helped by dredging.

310. At what other places have jetties been made?—Several applications have been made since 1834, when the last Act for the improvement of the Tay came into force for leave to extend some of the existing jetties; but in all cases they have been refused, from the conviction that they tend to retard the progress of the tide upwards.

311. Opposite the property of David Hay, Esq., Newburgh, there appears to be stone dykes near Mugdrum Island, have you visited that?—Yes, I have.

312. State the nature of them, and by whom erected?—They were erected partly by Mr. Hay, partly by Sir John Richardson, and partly by John Lee Allen, Esq.

313. How long have they been erected?—Some of them a good many years.

314. Has any application been made to remove them?—No.

315. What is the effect of their remaining?—Their effect is to form land, and to decrease the tidal space of the river.

316. Who are the conservators of the river from Perth downwards?—The city of Perth.

317. To what point?—To Invergowrie Burn; it is three or four miles above Dundee.

318. (*Capt. Beaufort.*) When you ordered all these piers to be removed, did you propose any other means by which the inhabitants might obtain a connexion with the river, any substitute for the pier?—Those were jetties for forming land, and not piers; between every one of them a crop of reeds was planted.

319. They were to act in order to make land?—Yes, that was the professed object.

320. (Mr. *Hume.*) Are the Commissioners to understand you to say that those dykes were formed, and that on each side reeds were planted with the view of forming land in the middle of the river?—Yes.

321. Has that been done to any extent in the neighbourhood of Mugdrum Island, or any other part of the river?—It has been done in various parts of the river.

322. Are the Commissioners to understand that land has been acquired by that means from the natural stream?—Not what we can call the natural stream, but in a part of the river which was daily covered by the tide.

323. Will you state one or two more of the encroachments?—At Nethermains Island in particular, opposite Mugdrum Island. I have myself observed the process of land making there on my visits occasionally to the river. I have seen the changes going forward to a considerable extent. It is very different now from what it was when the survey was first made; there is a much larger fore-shore in front of the island.

324. To what length does the dyke extending from Nethermains Island to the south proceed?—The dyke is very nearly 1000 feet long, I think, now; in fact, the dykes there are nearly meeting.

325. Do you mean to say that the dykes at the north side of Nethermains Island are nearly meeting the dykes at the south of Mugdrum Island?—Yes; in one case they are not very far from it, a few hundred feet.

326. Is not the effect of that to narrow and impede the flow of the river upwards?—Unquestionably it is.

327. Has there been any embankment formed on the north side, west of Nethermains Island?—There has.

328. Have you visited that?—I have.

329. Is that converted into land?—It is.

330. Have you visited a pier projecting from the lodge of Sir John Richardson's estate on the north side of the river to the cairn of stones?—Yes.

331. (*Capt. Washington.*) Were those dykes of which you are speaking erected by the permission of the trustees, opposite Sir John Richardson's, for instance?—Sir John Richardson's pier of Cairnie was by order of the Commissioners of the Tay navigation shortened, according to our recommendation, so as to avoid interfering with the stream; but there was to a certain extent liberty given to erect a low mound of gravel along the fore-shore, partly for the purpose of directing the currents into the south channel, and partly in order to compensate for the damage done to Sir John Richardson's fishings, for which the Harbour Commission were liable, and in obviating which it was desirable to meet, as far as was consistent with the interest of the navigation, the views of the tenants of the fishings.

332. (Mr. *Hume.*) Are we to understand that the conservators of the river of the city of Perth gave their sanction to Sir John Richardson for the projection of that pier?—They gave him their sanction to deposit the materials they were dredging on the opposite side of the river at the fishing cairns, and the dredged material was laid along the fore-shore, opposite Sir John Richardson's property.

333. Have those cairns, which appear on the map in the middle of the stream, been removed?—They have.

334. What has become of thematerials?—A great part of the materials were deposited opposite Sir John Richardson's grounds, which was also found a very convenient and suitable place.

335. Extending into the river?—No, extending chiefly along the inner bank; part, however, were deposited immediately below the pier which had been shortened in the line of the channel.

336. What has been the effect of that deposit of the materials there? Has it caused an accumulation?—The effect has been to throw the stream towards the south side.

337. The effect has been to impede, as far as it projects, viz., 500 feet into the stream, the flow of the tide?—To impede to a certain extent the flow of the tide there; but it also has the effect, we conceive, of deepening the channel at Kirwhinnel. The dyke of 500 feet long was not recently formed.

338. But while it deepens the channel at Kirwhinnel, does it not stop the flow to Perth?—To a certain extent it must, of course.

339. If there are a great many of those small impediments, such as you have spoken of, on each bank, do they not on the whole impede the flow considerably?—The aggregate effect of a very great number would be injurious.

340. Without entering into the details of all the encroachments, can you state what the depth of water was a few years ago, and what the depth now is, since some of those impediments have been removed?—Before the operations began in 1834, the depth of the river at Mill Hurst Ford, which is 3 miles below Perth, at high-water of spring tides, was 11 feet 9 inches, and at low-water it was very nearly dry, there being only 21 inches water.

341. What was the rise of the tide at that time at Perth?—The rise of the tide at Perth at that time was about 8 feet.

342. Did the Commissioners at Perth obtain an Act of Parliament to enable them to deepen the river downwards, and when?—They did in 1834.

343. Have those deposits been made opposite Sir John Richardson's land since the passing of that Act?—Yes, that was done subsequently to the Act; but not the formation of the dyke, which is older.

344. Did the Act direct them to deepen the river throughout from Perth downwards?—It directed them to deepen the river from Perth down to Newburgh, not lower; their operations do not extend below Newburgh.

345. But they removed the fishing cairns from the middle of the stream; and the deposit on the property of Sir John Richardson is within the space between Perth and Newburgh?—It is.

346. Then was not that a contravention of the Act?—No, because the dredged material must be deposited somewhere, and as close to the margin as possible is the place where it is least injurious.

347. Is it your opinion that all materials dredged from the bed of the river should be laid out on dry land, so as not to interfere with the flow of the tide?—I should say that it depends upon circumstances; the expense of doing so might be very great.

348. I am not alluding to the expense, but would not the doing that tend to improve the river, by keeping the flood and ebb clearer?—No; there are circumstances in which it might be advantageous to deposit materials within a tide-covered space, as at the Islands of Balhepburn, Sleepless, and Darry; I conceive that it was advisable to fill up the back lakes there.

349. Does not the filling up, in a degree, tend to retard the flow of the tide?—No, not particularly.

350. Will it not prevent it from flowing to the upper part to Perth?—No, for the space obstructed is compensated for by cutting and by deepening opposite; it would rather have the effect of quickening the tide, by giving it a better direction.

351. Then the opinion you have given of the propriety of filling up any portion, is on the assumption that you are to make a corresponding increase of depth in another quarter?—Yes, generally so; perhaps I might explain a little with regard to that. As a general principle it is not at all desirable to exclude any quantity of the tidal waters; but there may be particular cases in which to gain an object, in straightening the channel and giving it a better direction, you might exclude a very little of the tidal water without any disadvantage to the navigation.

352. That is wherever you can by that operation straighten the direction of the current you would give a greater impetus, and by means of that greater impetus counteract the greater impediment which would arise?—Quite so; for example, I conceive the straightening of the

A. Stevenson, Esq.

May 2, 1845.

current at the Earn, and the removal of the fishing cairns there, to have quickened the tide. I know it to have done so.

353. Who has superintended those excavations and clearances in the Tay?—My father, my brother, or myself have always done so.

354. Then you are able of your own knowledge to speak to those facts?—Yes.

355. You have stated what the rise of high water at Perth in 1834 was; since the removal of those impediments what has been the rise of high water there?—The tide now reaches Perth about 55 minutes sooner than it did before those operations.

356. How much higher does it rise?—It does not rise much higher, I think hardly at all, but there is deeper water—the channel is deepened.

357. At Mill Hurst ford, where there were, in 1834, 11 feet 9 inches of water at highest spring tides, and it was nearly dry at ebb, what is the depth of water now?—It is about 4 feet 9 at present at low water, and at high water it is nearly 16 feet.

358. That is, you have 4 feet 9 where it was nearly dry, and 16 feet where it was a little more than 11?—Yes.

359. Is that depth of the channel carried all the way from Perth downwards, or do you allude only to one particular part?—In some places the channel has not been deepened at all; that is, it did not require to be deepened; it was naturally of a proper depth.

360. Is the shallowest part of the river 16 feet at high water?—Fifteen feet; the tide now does not rise to a much higher level than it did in 1834, but there is an increased depth of water.

361. By what means has that increased depth of water been gained?—It has been gained chiefly by the removal of the fords, which acted like steps against which the tide in its upward progress impinged, and waited some time till it had risen to the top and then made a sort of jerk and so got into the next space; those impediments have now been removed, and the tide flows with a more equable velocity throughout the whole space than it did before.

362. Has the removal of those projecting dykes and encroachments assisted to increase the flow and also the scour?—None of those dykes have been removed under the operations except those at the Earl of Zetland's property, the effect of the removal of which has not yet been seen.

363. Have you made any report to the magistrates of Perth of what the depth of the water might be, if all the impediments that you can point out in the navigation were removed?—I reported to them, that, by dredging to perhaps the same extent as we have done, and removing 800,000 or 900,000 tons of materials from the bed it might be possible to get a depth of nearly 20 feet up to Perth.

364. Do you mean that by removing the cairns of stones that have been placed or merely the fords?—Deepening the fords and shallows chiefly; there are not many more obstructions in the shape of cairns, they have been removed; but still it is a constant warfare with the proprietors; they are constantly trying to project fishing stations from the banks.

365. Are any of the proprietors Commissioners under the Act?—Several of them are.

366. Does that in any way interfere with the engineers proceeding to remove those obstacles?—No, I cannot say that I have had any difficulty, from the interference of individual Commissioners.

367. Have you found a disposition to encroach on each side of the bank?—Yes.

368. Do you consider looking to the manner in which this river and other rivers that you know are managed, that a superior authority to the local management ought to exist anywhere if the navigation is to be made as perfect as it is capable of being made?—I think it would be very beneficial to have some final authority to whom an appeal could be made as to whether any proposed change was injurious or otherwise.

369. Do you mean that there should be an independent authority who should be appealed to on every encroachment or interference with the navigation of rivers?—Yes.

370. Do the observations you have made now with regard to the Tay apply to your experience of the Lune and Ribble?—They do.

371. Do you find the same tendency on the part of the proprietors of land on the sides of the rivers to encroach on the navigation at those places?—There is a very general desire to form land on the shores by jetties.

372. The formation of that land on the banks must tend in every instance to exclude the tide must it not?—Yes.

373. And consequently, by degrees, to impair the navigation?—Yes.

374. What is the effect of allowing piers and encroachments at different points to be made; are not banks likely to be formed by the tide taking a set from those encroachments?—In general deep hollows are formed in one place and large banks adjoining; and the navigable current receives a twist opposite each jetty.

375. (*Chairman.*) It produces a sort of eddy?—Yes.

376. (Mr. *Hume.*) And those banks, formed by those projections and jetties, become the principal impediment to the navigation?—They do; they twist the river round instead of allowing it to take a straight course; they produce sharp turnings and retard the currents both up and down.

377. From your experience, do you consider that the Admiralty, or some competent authority, ought always to have a superintendence over navigable rivers and harbours?—I think it would be most desirable.

378. (Mr. *Godson.*) Do not you think that it is absolutely necessary?—Yes, I do; because attempts are sometimes made even to destroy navigations.

379. (Mr. *Hume.*) Are not the interests of those local Boards and local Commissioners sometimes at variance with the public interests in that respect?—Sometimes they are, unquestionably.

380. The proprietors of the banks desiring to gain land by encroaching on the navigation?—It is chiefly the proprietors of the neighbouring land who are interested in gaining the soil.

381. But are not the proprietors often Commissioners of the local Boards?—Sometimes they are.

382. Would you recommend the appointment of independent Commissioners, that is, Commissioners whose local interests are not affected?—Yes.

383. What kind of check or control do you, as an engineer, think would be best, in order to protect and improve the navigation?—The submission of all plans proposing any changes on the sides of rivers to some public Board, would seem to me to be a great check,—in fact, to require the approval of a public Board before any change could be brought about.

384. Are the Commissioners to understand you to mean that all encroachments formed within high-water mark, in every navigable river, should be submitted to that authority?—Yes, I think so.

385. (Mr. *Godson.*) For that purpose you would require a public officer to report when there were encroachments going on?—That would be necessary, undoubtedly.

386. (Mr. *Hume.*) My question to you as to a check had allusion to the existence of a permanent superior authority, having the conservancy of all rivers; is that what you would recommend?—Yes, because those encroachments are often made in a very short time; in a few days a serious encroachment is made, without any previous notice.

387. Would you consider it necessary to have a superintendent of every creek and river, and a map lodged with that competent authority, that he might be able to check any encroachment?—I think they could not act without local officers and correct plans for reference.

388. (Mr. *Godson.*) Could not some person belonging to the Customs have such a charge of the river as to be continually reporting the beginnings of encroachments?—I think there might be such a person.

389. (Mr. *Hume.*) Have you any further observations to make on the state of the navigation, and the velocity of the tide in the Tay, before and since your operations?—Previous to the commencement of our operations in 1834, the velocity of the tidal wave at Dundee and Newburgh, (the distance between them being 22 miles,) was exactly the same—there is no difference there—no operations have taken place below Newburgh.

390. (Mr. *A. Chapman.*) But may not it be the case, that by embankments being properly placed, the velocity of the tide may be increased, so as to give additional scouring power to the river?—Yes; if embankments are properly placed. We have placed three embankments with that special object in view. The great object I conceive to be to remove every kind of obstacle to the natural flow of the tide upwards, whatever it be, whether it be a sudden change of level in the bed of the river, or the projection of artificial works, such as jetties from the side, or very sharp turns in the course of the river.

391. (Mr. *Hume.*) Do you give that answer referring to the principle to which you before referred, that for all encroachments on either side compensation in excavation should in some way be given?—I do generally; but I do not go the length of saying that the principle of shutting out as small a portion of the tidal water as possible is so very important that it may not be departed from for some better reason.

392. Do you not admit that the principle of shutting out as small a portion of the tidal water as possible, is the rule upon which you should act, but that there may be some instances where a compensating advantage by filling up or giving a better direction to the stream may be derived?—Yes, I will suppose a case of this kind. Where you have a river coming into a flat channel and moving about tortuously in every direction, I think it might be a legitimate improvement to form a stone wall to guide that river, (as was done at the Ribble) in its course through the sand; that wall might abstract a very small quantity of the tidal water which would be in proportion to its mere displacement and it might not be compensated for, as there might be no means of compensating for it, yet I think the loss of water would in general be very unimportant.

393. Do you consider the particular height of that wall to be important—whether it should be quarter, half, or full-tide high?—It would depend very much on the situation, but generally I should wish to keep that wall very low, rather to make it as a guiding point for the entrance of the flood, and for the recedence of the ebb—the last quarter of the ebb.

394. (*Capt. Washington.*) And that is the most important part of the tide?—The entrance of the flood is a very important agent in stirring the bed.

395. (Mr. *Hume.*) Will you proceed in describing your farther operations?—The operations have taken place, as I said before, chiefly at those fords above Newburgh, between that and Perth. From Newburgh to Perth the velocity of the tidal wave, previously to those operations, was at the rate of 3·42 miles an hour. Now that velocity is very different. From Newburgh to Carpow it is 3·17 miles an hour, from Carpow to Kinfauns it is 5·36, and from Kinfauns to Perth 6·93. The mean velocity for the propagation of the tidal wave between Newburgh and Perth is now at the rate of 5·13 miles an hour, instead of 3·42 as formerly.

396. Do you consider that to have arisen from the removal of the impediments you have spoken of?—There can be no doubt of it.

397. Have you any other observation to make respecting the Tay?—No, I have nothing more to add but what I give in detail in this Report, (*delivering in his Report on the Tay.*)

398. (*Capt. Washington.*) Will you state the relative velocity of the tidal current in 1833 and the present time?—I have made no observations on that.

399. (*Capt. Beaufort.*) Have any alterations taken place at the mouth of the Tay which may have affected your tidal wave?—There have been changes at the mouth of the Tay which I do not know the extent of. I have not had an opportunity of examining them, nor

A. Stevenson, Esq.

May 2, 1845.

do I know whether they are independent of our operations, or whether they are in consequence of them.

400. (Mr. *Hume.*) Who has charge of the mouth of the Tay?—The Trinity House, or Seamen's Fraternity of Dundee, have charge of the lights and buoys.

401. Do you know what engineering officer is employed under them?—They employ us about their lighthouses.

402. (*Capt. Beaufort.*) The banks of both points at the mouth of the Tay have altered their shape?—They have. I have not been employed, but I am informed that a survey has been taken by order of the Admiralty, and from that the Commissioners will get the necessary information upon the subject. (*See Report on the Tay, by the Admiralty Surveyor, in Appendix.*)

403. (*Capt. Washington.*) Does not the Tay drain the largest extent of country of any river in Great Britain?—It drains a very large extent of country, 2283 square miles.

404. Can you tell us the quantity of fresh water brought down by the Tay?—It brings down 273,000 cubic feet in a minute.

405. Is that the mean discharge of the Tay?—It is.

406. All the year?—Yes.

407. That is including the Earn?—Yes, it is the Tay and Earn together; the Tay itself discharges about 220,000 cubic feet.

408. Can you state at all the relative proportion between the fresh water brought down by the river and the tidal water carried up by the flood?—No, I cannot.

409. You state that the Tay drains 2283 square miles; from what do you take that?—I take it from Arrowsmith's map; and the discharge of the Tay I take from the measurement by Professor Anderson, of St. Andrew's; and the discharge of the Earn is from a measurement of our own; it discharges 54,959 cubic feet a minute.

410. (Mr. *Hume.*) What proportion does the discharge you have given of the Tay bear to the discharge of the Thames?—Mr. Rennie states the Thames at 80,000 cubic feet a minute, measured at Teddington weir, to which the tide rises.

411. (*Capt. Washington.*) What quantity of soil has been dredged up from the Tay, under your direction?—The whole quantity, since the operations began, is 841,480 tons.

412. Where do you deposit the soil dredged up?—A great part has been deposited at the back of Sleepless Island, at the back of Millhurst, and at the back of Balhepburn Island.

413. (*Capt. Beaufort.*) In the way of the channel?—No; it was formerly a back channel; it is now shut up by the three embankments.

414. (Mr. *Hume.*) Do you not consider that that has in some measure impeded the flow of the tide upwards?—No, I conceive not. The fact of the existence of this back channel, in connexion with the shallow part of the river at the top of the island, proves to me,—(I will not say) that the ford was the cause of this channel; but, at all events, they were connected together as cause and effect; and, undoubtedly, the removal of the ford, and the shutting up of that channel, has greatly improved the principal channel.

415. Do you think that the improvements in the main channel, and the removal of the ford, was a sufficient compensation for that which you filled up behind the islands?—No, I think not; and we found it not to be the case till we cut away the principal part of the fore-shore, particularly at Sleepless, and also at Balhepburn and Millhurst fords.

416. Do you consider that you gave compensation in space for what you were filling up behind the islands?—I think fully; and I think the rapid propagation of the tide-wave through it fairly shows it.

417. (*Capt. Washington.*) How high above Perth does the tide make itself felt?—It goes two miles and a-half above Perth.

418. About what distance from the sea?—About 35 miles.

419. (Mr. *Hume.*) Has the tide extended its range no further than that?—No, I have not observed it; but I do not know that it could, because there is an obstruction in the bed of the river at the bridge of Almond.

420. (*Capt. Beaufort.*) Does the salt water go up to that point?—No, it is only up to that point that the tide is felt.

421. (*Capt. Washington.*) How high does the salt water go?—Judging from the marine productions, a very little above Mugdrum Island.

422. (*Capt. Beaufort.*) Is the water salt at Perth?—No.

423. (Mr. *Hume.*) How far is Mugdrum below Perth?—It is about 25 miles from the mouth of the river, and seven miles and a half below Perth.

424. And the tide flows up 10 miles more?—Yes.

425. (*Capt. Washington.*) Are you at all acquainted with the Tay below Newburgh?—I have very often sailed up and down it. I should not say that I know it minutely as an engineer below Flisk Point.

426. Have you seen the jetties thrown out by Lord Kinnaird and Mr. Allen of Errol on the north side of the river?—Yes, I have.

427. Do you not consider that they will be very detrimental, if completed, to the navigation of the river?—I think they will shut out a very large portion of the tidal space of the river.

428. Looking at the plan showing the jetties thrown out by Lord Kinnaird and Mr. Allen, what area of tidal water will they exclude?—Roughly, I should say two square miles and a-half of surface (nautical miles), or about 1800 acres.

429. What proportion, in your opinion, will that bear to the whole estuary?—I cannot state the proportion; but it is a very large proportion.

430. To what extent are the jetties thrown out across the river?—The longest is about half a mile.

431. (Mr. *Hume.*) Will not every such encroachment on the banks counteract the benefit

which you have shown to arise from dredging and removing the difficulties which oppose the improvement of the river?—I am afraid I could hardly answer so absolute a question as that, because there might be an encroachment for any important purpose, putting in a weir, for example, which would be still an encroachment, and yet the quantity of tidal water obstructed by it might be so small as to be of no practical importance.

432. Supposing those encroachments to be for the purpose of gaining arable land from the river, what would be the effect?—The effect would depend upon the depth of the water in the area to be enclosed. I may observe, in regard to that question, that there are so many circumstances in each particular case, that it is hardly possible to give a general answer, further than to state that any obstruction of the tidal waters is disadvantageous, inasmuch as it affects the scour; but I can conceive a river to be too wide at a certain place.

433. Not as regards the bed?—Not if you consider the bed alone; but if the mouth of the river be very narrow, and the space above is excessively large, it is conceivable that it might require the whole time of the flood to fill that space before it could affect the upper part at all, and in this way the beneficial effect of the tide might, in such cases, be circumscribed. Those are extreme cases, and it becomes a difficult thing to answer questions of a general kind.

434. (*Capt. Washington.*) But is not maintaining the width of a large river or estuary of great value, in order to maintain the depth by means of the wash of the sea?—It is.

435. Were you ever consulted on these projections of Lord Kinnaird?—My brother visited them, and reported to Lord Kinnaird unfavourably of the projections, as regarded the navigation.

436. (*Capt Beaufort.*) What is your opinion of the effect that would have taken place if Government had permitted the bridge at Mugdrum to be made for the railway?—I think it would have destroyed the navigation of the Tay upwards entirely.

437. (Mr. *Hume.*) Were you consulted upon it?—I was employed to report upon it by the Tay Navigation Commissioners.

438. Did you give an opinion as to what the effect of the passing of the railway would be?—Yes, I gave an opinion that it would be prejudicial to that navigation.

439. Did you give a written report?—Yes; it is printed, and I beg to lay it on the table.

440. (*Capt. Beaufort.*) What is the lowest part of the river which you think a bridge might with impunity be thrown across?—I think certainly not lower than the town of Perth, if so low.

441. Do you apprehend any mischief from the proposed railway bridge across the river Earn?—No, I think the evil would not be so great there.

442. (Mr. *Hume.*) Is the Earn navigable?—For small barges.

443. Do they propose to throw a bridge over the part that is navigable?—Yes, but it is a swing bridge.

444. Have you and your brother been employed to report on the navigation of the river Ribble, which runs up to Preston?—We have. (*The Witness produced a map of the River Ribble.*) River Ribble.

445. What was the nature of your examination and report?—The report recommended the deepening of the upper part of the river, by removing a large band of solid rock which ran across the river, and dredging in various parts of it, and also removing a number of jetties, which were laid down for the purpose of forming land, and which tended to twist the river, and to throw it into deep holes. This plan shows the former state of the river. (*Witness exhibited a plan.*)

446. In what year did you begin your operations there?—In 1838.

447. What was the depth of the water, then, up to Preston?—I do not remember the exact depths, but I think between five and six feet depth of water has been obtained in the river, by the operations in the lower part, where the dredging was. The excavation of stone in the upper part will admit of deepening all the way to Preston to 20 feet deep.

448. To what extent has the dredging been carried?—The dredging has been carried between the town of Preston down towards Clifton Bank. A wall has been formed for the purpose of directing the current towards the Nase Point, at Freckleton.

449. What is the depth of water now maintained at Preston?—Up to Preston Marsh I think there are 14 feet. But it is some years since I visited Preston. My brother has the chief charge of that work.

450. Has the effect of removing those jetties and dredging been to increase the depth of water?—It has.

451. Were you able to see whether any encroachment of land has been made on either side of the river, formerly covered by the tide?—No; the effect of the jetties was rather to disturb the channel, and make the bed of the river irregular in respect to its channel—deep in some places and shallow in others; and those jetties have been removed, and the channel made more regular.

452. Are there any other impediments that you contemplate removing, in order to increase the depth of water?—No; the removal of the rock has been completed; about 31,000 cubic yards of rock were excavated by means of cofferdams.

453. Did you act on the same principles, in clearing the Ribble, as those you had laid down, and on which you have acted respecting the Tay?—Yes, the same principles in deepening the upper part and removing anything tending to twist the stream.

454. Did you find the tide came sooner up to Preston than formerly, in consequence of those operations?—There is a change, but I am not acquainted with its extent.

455. Generally speaking, are we to consider that the same results took place from your operations in the Ribble as took place from your operations in the Tay, though not to the same extent?—I do not know that they may not have been to the same extent, but no Report has been made; the result has not been called for in any way.

A. Stevenson, Esq.

May 2, 1845.

456. But, having acted upon the same principles, do you think that it would be advisable to carry them out in any other case?—Yes, they excavated 31,000 cubic yards of rock from the upper part of the river, so as to give a depth of 20 feet at spring tides at that place. This is a great obstruction removed, and it was a work of great difficulty.

457. By that means principally, you consider, in addition to the removal of the jetties, you obtained that increased depth of water?—Yes, and by dredging.

458. Do you contemplate any further operations in the river, in order to increase the depth?—The dredging will be carried on, and the wall completed, in order to direct the current.

459. Is there still any capability of improvement to a great extent?—There is.

460. What depth do you consider may be obtained at Preston?—I have not considered that, but I do not see any limit to it within the depth of the rock cutting.

461. Have you been employed on the Lune?—Yes, *(producing a map of the River Lune.)*

462. Will you state in what condition you found it when you first went, and what operations you have carried on there?—No operations have been carried on. Proposals were made for operations, but the Harbour Commissioners of Lancaster had not the funds to do any work there. We surveyed it, and pointed out the changes that might with advantage be made; but no changes have been made.

463. What is the distance from Lancaster to the sea?—About six miles.

464. Vessels of what draught of water can get up to Lancaster?—The depth of high water would be, if the operations we have recommended were carried out, about 16 feet up to Lancaster.

465. What is the present height?—Less than 13 feet over the ford at spring tides.

466. By what means do you propose to raise it to that depth?—Chiefly by dredging.

467. (Mr. *Godson.*) There is a ford to be removed close to Lancaster, called Scale Ford?—Yes, that is to be removed by dredging.

468. (Mr. *Hume.*) Where are the docks situated belonging to Lancaster?—They are situated at Glasson.

469. What is the depth of water at Glasson?—The depth of water at Glasson is 25 feet 6 inches.

470. Did your report contemplate the deepening of the river up to Lancaster, to that extent?—No, the report only contemplated deepening it to 16 feet at high water.

471. Do you consider it capable of being deepened up to 25 feet 6 inches, the same depth as at the docks?—It would be very difficult to get it to that depth, as the fall on the river's bed is very great. It would be still more difficult to maintain it at that depth, as the fall on the river's bed would be removed.

472. (Mr. *Godson.*) There are two fords that you would have to remove?—Yes; there is Scale Ford, and a ford a little below, called Baffler's Ford.

473. About how much money would it take to remove those two fords, so as to have 16 feet of water up to the quay-side; would it take 10,000*l.*?—No; I should think it would be considerably under 10,000*l.*; but I do not recollect the figures at this moment for these particular portions of the work.

474. Is there any other impediment which you would have to remove of an expensive nature for the purpose of enabling vessels drawing 16 feet to come up to the quay side?—Heaton Shoal.

475. What would you do with that?—I would dredge it, and the same with Colleway Shoal; and I would widen the part opposite Red Bank, and straighten and deepen the channel generally.

476. (Mr. *Hume.*) Do you consider all that work possible to be done within the estimate of 10,000*l.*?—No; but I can supply the Commissioners with a copy of the estimate.* The amount for the whole works was somewhat above 13,000*l.*

477. (*Capt. Washington.*) What is the rise of the tide at Lancaster?—It is about 10 feet.

478. What is the rise of the tide at the mouth of the Lune?—At Glasson it is 21 feet.

479. Does the bed of the river rise very much between Glasson and Lancaster?—There are about 11 feet of rise on the low-water line.

480. (Mr. *Hume.*) Did you survey it?—I did not; my brother did.

481. (Mr. *Godson.*) Are not the impediments those you have mentioned of the shoals?—Yes.

482. Would there be seven places requiring dredging within those six miles?—Yes.

483. (Mr. *Hume.*) Is it your opinion that those impediments to the flow might be entirely removed?—I see no difficulty in getting 16 feet depth the whole way up.

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* Probable Estimate of the Expense of Improving the Navigation of the River Lune, so as to obtain a depth of 16 feet at high water of ordinary spring tides, up to the quays of Lancaster, by Robert Stevenson and Sons, civil engineers.

Expense of a dredging machine worked by an engine of 12 horses' power, with punts and apparatus		£5,000	0 0
Ten months' work of a dredging machine, at 175*l.* per month		1,750	0 0
		6,750	0 0
Incidents on the above sum of 6,750*l.*, at 10 per cent.		675	0 0
		7,425	0 0
To complete the further improvements of widening and straightening the channel shown in the plan:—			
Three seasons' work of a dredging machine, taken at 1,750*l.* per annum	£5,250		
Incidents, at 10 per cent.	525		
		5,775	0 0
		£13,200	0 0

Edinburgh, Dec. 14, 1838.

ROBERT STEVENSON and SONS.

A. Stevenson, Esq.

May 2, 1845.

484. (Mr. *Godson.*) Have the inhabitants been obliged to have a new quay between Baffler's Ford and Scale Ford?—Yes, they have a quay there.

485. (Mr. *Hume.*) Are you aware whether any portion of the banks of the river has been enclosed for agricultural or other purposes?—No, I do not know that fact.

486. (Mr. *Godson.*) Have not the corporation of Lancaster, by an Act of Parliament, enclosed several hundreds of acres of marsh land upon the banks of the river at Marsh Point?—I am not aware of it. I do not remember to have heard it.

487. (*Capt. Beaufort.*) How many arches are there to the present bridge at Lancaster?—I think five.

488. (Mr. *Hume.*) Do you consider that the principles you have laid down on the improvement of the navigation of the Tay would apply equally to all the improvements of the Lune river?—Yes, I conceive so.

489. Does the report you have made direct the attention of the Commissioners to those principles?—It does. On everything connected with the Lune I would refer to my brother.

490. (Mr. *Godson.*) Looking at this plan, by which the railway proposes to cross the river, supposing the quay were built below the bridge, would such a bridge as you see depicted impede or not impede the navigation?—My impression is that it would not, but I should not like, without deliberate inquiry, to commit myself by giving an opinion as to the effect of a plan by another engineer.

491. (*Capt. Beaufort.*) Would it be necessary to have a drawbridge there?—No, I think not.

[*The Witness withdrew.*]

Adjourned till Wednesday next, at 1 o'clock.

Wednesday, May 7th, 1845.

Present:—

Captain Sir GORDON BREMER, C.B., in the Chair.

Mr. HUME, M.P.	Captain BEAUFORT, R.N.
Mr. A. CHAPMAN, M.P.	Captain WASHINGTON, R.N.
Mr. GODSON, M.P.	

Mr. *William Bald,* examined.

William Bald, Esq.

May 7, 1845.

494. (Mr. *Hume.*) Did you report at any time on the extension of the river Clyde navigation upwards, above the city of Glasgow?—Yes; I drew up a report which is dated Glasgow, 31st July, 1839.

495. Did you, in that report, show how the Glasgow Waterworks could be supplied with water, and all weirs and impediments in the river removed, so that the tidal flow might be increased to great advantage, and the navigation thereby improved?—Yes.

496. Did you point out in what way that might be done?—The report states: "The principal objection offered to the removal of the weir at the Glasgow New Bridge has been made by the Glasgow Water Company. They state, that it would lower the level of their present supply. Now, looking at the Glasgow Water-works, and the numerous public interests connected with them, both industrial and manufacturing; looking at the immense steam-power employed in the water-works, amounting to no less, when completed, than 682 horse-power; and, again, at the vast capital which has been invested in those works, it really, on public grounds, becomes a question of the greatest importance in deepening the river Clyde, and improving and enlarging the port of the city of Glasgow, to preserve these water-works from sustaining any injury, either in lowering the existing level of the water in the Clyde or deteriorating the quality of the water which affords the supply. On this most important subject we fortunately have on record the evidence of the late Mr. Thomas Telford, and we have also the very clear and very able evidence of Mr. James Jardine, engineer to the Edinburgh Water-works: both of these gentlemen mention distinctly, that, if the bottom of the ford at Dalmarnock Bridge be secured, so that its present level remain undisturbed, the weir may be taken away at the Glasgow Bridge, and the Clyde deepened between Dalmarnock Ford and that bridge for about six feet, without, in their opinion, doing any injury to the Glasgow Water-works. But be it understood, that the work which they recommended was not to rise above the level of the present bed of the Clyde at Dalmarnock; for Mr. Telford says, in his evidence, that when the bed of the river would be secured 'a stranger would be unconscious of any such operation having been performed there,' because no weir would be seen traversing the Clyde. Numerous interests would, I fear, offer many serious objections to the erection of a weir rising even a few inches above the bed of the Clyde at Dalmarnock Ford. Attentively reflecting on the evidence of Mr. Telford and Mr. Jardine regarding the Glasgow Water-works, and considering that the ford of Dalmarnock is at present nearly 18 inches above the level of the Clyde, where the present supply is taken for the Cranstonhill Water-works, I think it possible to obtain a supply of water from the level of the river at Dalmarnock without raising its level by the construction of any weirs rising above the present bed of the Clyde at that point, by simply securing the existing level of the river waters at the ford; for I frankly avow that I am decidedly opposed to the erection of any weirs across the bed of the Clyde. It would, perhaps, even be much better to carry a sufficient quantity of water from a still higher level of the Clyde to supply the water-works, than in any manner to interfere with the river channel by the erec-

William Bald, Esq.

May 7, 1845.

tion of engineering works which would obstruct the free passage of the land and tide waters, and prevent the navigation from being improved hereafter in the higher reaches; and also to enlarge and extend those natural tidal flows or scouring powers which would act so beneficially, not only in cleansing all deposition caused by the city sewers, but would also be of great benefit to the harbour in keeping it clear, as well as the whole channel-bed of the river downwards. I am unable to find language to express all my thoughts on the great value which I attach to this upper scouring power, and on the necessity which exists that no part of the bed of the river shall ever be encumbered either with weirs, dykes, or locks where it may be possible for the tidal rise to reach, or to which it at present extends. Looking at the triumphant success with which the open tidal estuaries of rivers have been navigated since the application of steam-power to maritime purposes; looking at the improvements which are being made in so many rivers, not only in Great Britain and Ireland, but also on the new and the old continents, to facilitate and extend the progress of this power into the most remote corners where the tide flows, and the extension of this power which so peculiarly characterizes and adorns the Clyde—the cradle of steam navigation—its further extension into the highest tidal reaches of the Clyde at once claims and demands the deepest attention of those entrusted with the direction and improvement of the river and the port of this great city. Reflecting on the events of the last 25 years in the improvement of the lower Clyde, who can tell to what an extent the improvement of the upper reaches of the river may not be carried?"

497. If that weir was removed, as you suggest, and the water taken above Dalmarnock, would that, in your opinion, give free navigation from Glasgow upwards to that spot?—Quite so.

498. Have any measures been taken to carry out that recommendation of your report?—None.

499. Have you in any other reports addressed to the Clyde trustees shown the great value it would be to the navigation to increase the tidal flow up to the highest part of the river?—Yes; 23rd of September, 1844.

500. What is the nature of that report?—The nature of that report is to show the great injury that the navigation would sustain by filling up even any of the tributary streams connected with the river Clyde where the tidal flow reaches.

501. Have any of the tributary streams to which the tide flows in the Clyde been shut up or the flow impeded?—Yes; a vast quantity of peat or moss has been thrown into the Black Cart River and the River Gryfe.

502. What has been the effect of that peat and moss thrown in there?—To shut out a portion of the tidal flow.

503. How high up the Cart from the Clyde does the river Gryfe flow in to it?—About two miles and a half up.

504. What depth?—Barges carrying 40 tons can ascend up the River Gryfe.

505. Has the water suffered any decrease in depth by the accumulation of peat?—A vast quantity was lying in the bed of both the Gryfe and Black Cart.

506. Why did you not remove it, if you are of opinion that it would decrease the tidal flow?—It was thrown in by Mr. Spears, a proprietor in the neighbourhood, who was removing the black stone moss.

507. Did he make any application to any body?—No; but the Clyde trustees instituted proceedings against him.

508. What was the result of those proceedings?—I believe they are still at law.

509. Then they have endeavoured to prevent it?—Yes; and in order to show the great value of the preservation of the back tidal water there is an Appendix appended to that Report, which is very short, which shows the great value which the people on the Continent give to a back water scour to harbours generally. *(See Appendix*, No. 5.)

510. Are you of opinion that much benefit can be derived by reservoirs for scouring?—Yes; the harbour of Dunkirk was an example of it.

511. Is it your opinion that every tributary, however small, of the Clyde or any other river which you wish to keep navigable should be kept open?—Every auxiliary branch should be carefully preserved.

512. The destruction of every auxiliary tends to injure the flow, and consequently to destroy the principal harbour?—There is no question of it.

513. Has the machinery for deepening the Clyde navigation been improved since 1839?—Yes; there has been a new dredge board built capable of working in from 17 to 19 feet depth of water.

514. With that you have been working?—Yes.

515. Did you suggest any further improvement, and has that been adopted?—Yes. I suggested an improvement to work the boats forward by steam power instead of manual labour, by which the deepening force was enabled to raise annually about 80,000 cubic yards or more additional, &c. &c. &c. *(See Appendix*, No. 3, before referred to.)

516. With a saving in labour and an increasing of work?—A saving of manual labour and an increasing of work of about 80,000 cubic yards annually. I got a tug boat built with two engines, each 30 horse power, which boat and engines have given the greatest satisfaction, the engines were made according to a specification, and were executed by Messrs. Smith and Rodgers, of Glasgow. Two years ago I got a model made for a new diving bell boat, to be formed of iron, and to have improved diving-bell machinery placed on board of her, for the purpose of lifting the large stone boulders and rocks from the channel bed of the Clyde, which damage and destroy the copper on the bottom of the large ships, whereby the timber becomes immediately exposed to the ravages of the teredo navalis; such ships going long voyages are placed in the most imminent danger; lives and property are perilled when they sustain such

damage. Therefore every exertion should be made to remove all the rock boulders and stones from the bottom of the ship channel of the Clyde, and which ship channel through all its hard and rocky parts, should be deepened and widened to a much greater extent than any other part of the channel, because when a large copper bottomed ship, deeply loaded, grounds for want of tide water, on any part of such a hard and dangerous bottom, she must inevitably be seriously injured, not only as regards the copper on her bottom, but also twisted or strained in her framing. The proposed new iron bell boat, which I had recommended, has not yet been made. It may be reasonably asked, what are a few hundred pounds paid for such a boat, and the annual expense of working her, compared to the loss of even one of those large ships and cargoes, worth perhaps in value, some of them, not much less than 40,000*l.*? Notwithstanding all this, there is lying on the table an order dated April, 1842, (in the hand writing of the late Mr. John Spreull, treasurer to the Clyde trustees,) addressed to the river foreman, directing him to discontinue the working of the two diving bells, and consequently, any further removal of those stones and boulders of rock from the bed of the channel of the river; and observe, this done in my absence, while in London on the trustees' business. With regard to improving the deepening machines, by still further increasing their power and labouring force, I shall hand in some extracts from my reports on this important subject, and also the copy of a letter which had been addressed to the chairman of the Committee of Finance. (*See Appendix*, No. 6.)

517. Can you state shortly the extent of the works which have been executed in the harbour of Glasgow and the river Clyde since 1839?—There have been executed and finished 1120 lineal feet of stone quay walls; 160 lineal feet of stone breast quay walls; 1032 lineal feet of wooden wharfs, including Bowling Wharf; 1447 lineal feet of new sheds; 3703 lineal yards of water-pipes; and 101 fire plugs. Bowling Basin contains an area of 14 acres. Govan Ferry Slip and quay wall 170 feet long. The harbour has been enlarged to an extent of more than seven acres. Many hundred feet of old quay wall on the north side of the harbour have been secured by piling 40 feet long each, and plans have been drawn out to secure a part of the south quay walls of the harbour which are now in progress of execution.

518. Have these seven acres of area been an addition to the place where ships can lie?—Yes, an additional surface of water.

519. Within what limit have these seven acres of space been added to the harbour?—Within less than a mile.

520. What effect have those works that you have mentioned had on the harbour?—These works have increased the accommodation for the trade considerably.

521. They have had no effect in deepening the water, but that has been done by dredging?—By dredging and in the construction of those dykes down the river.

522. You state them as an improvement to the harbour accommodation?—Yes.

523. (*Chairman.*) Ships of what draught of water can float in, in the increase of seven acres?—From 16 to 17 feet in the part deepened in the lower harbour.

524. Ships of 500 tons?—Ships of 600 tons in the lower harbour in part of the deepenings.

525. (Mr. *Hume.*) Have you any further information to give?—I beg leave to read the following document:—"Mr. Maconochie is directed to discontinue working the Rashalee Quarry, and to lay up the stone punts till further notice. To employ no more men in repair of the sloping dykes than will keep them from falling down. To discontinue working the diving-bells, and, when laid up, to employ only one man to look after both bell-boats. To pay off what men can be spared in the harbour—say masons, joiners, smiths, causewayers, or labourers, and to give notice that the surveying party are not to proceed with taking soundings above Bowling Bay. Glasgow, 18th April, 1842."

526. What is your object in reading that?—There are about 2200 yards of the bed of the channel of the Clyde incumbered with large whinstone boulders, between the west end of the New-shot Isle, and Erskine Ferry. It became important that those boulders should be removed out by the diving-bells. This order was given in the beginning of the season to discontinue the working of the bells, when the days were long, when the tides were low, and when it was absolutely necessary to remove those immense boulders; for this reason—that the large vessels going up and down the river got their copper sometimes stripped off by those boulders if they touched the bottom. I continued the working of the two bells in clearing the channel since that period up to the present, and disobeyed this order.

526. By whom was that order given to discontinue the works in 1842?—I am not able to answer, but the hand-writing is the late Mr. Spreull's, treasurer to the trustees, and it was handed to me by the river foreman on my return from London, and it was, no doubt, issued under the official authority of the chief of the executive department.

527. Did you remonstrate against that order of the trustees?—I remonstrated to several of them, and I persevered in keeping the bells on the hard ground; and I covered a space near the entrance of their meeting chamber with the fragments of sheets of copper and pieces of iron and lead which had been stripped off the bottom of large vessels, and which had been taken up by the diving bells from the bottom of the navigable channel in the river; and when they saw those fragments, and the serious injury which the bottoms of the ships had sustained, they were convinced of the propriety of my proceedings in persevering with the diving-bells and removing those boulders out of the bed of the channel of the river.

528. Have all those boulders been removed?—Not entirely; there is a good deal yet to be done both in widening and in deepening the navigable channel. It is the most dangerous part of the whole Clyde navigation to ships.

529. Are they now at work upon them?—Yes, I believe they are with the diving-bells.

530. (*Chairman.*) Then the operation of these diving-bells was suspended merely temporarily; how long were they laid up?—I am not aware that they were laid up at all. Orders were given, and the orders were disobeyed on my return from London to the Clyde.

William Bald, Esq.
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May 7, 1845.

531. (*Capt. Beaufort.*) Can you state anything like the quantity of whinstone boulders that they remove?—Year ending 1843, there were removed 969 tons, and year ending 1844, there were removed 1033 tons. There is a regular account kept what each bell lifts per day, per week, per fortnight, and also of the dredgers.

532. (Mr. *Hume.*) Were any other works begun by you as necessary to improve the navigation, interfered with and stopped by order of the trustees?—None, except the opening of the south channel of the Newshot Island.

533. Was any complaint made against you for persevering in using the bells and clearing the boulders, notwithstanding that order being given to your deputy?—None, the numerous fragments being shown of copper, lead, and iron, taken up by the bells from the ship channel of the river, and which had been torn off from the bottom of the ships by the rough rocky ground, settled that question effectually with the river trustees.

534. (*Chairman.*) Then you are of opinion that your acting on that order would have been most injudicious and prejudicial to the river itself?—Highly injurious to the navigation, and dangerous in the extreme to the shipping engaged in the foreign trade.

535. (*Capt. Washington.*) Can you tell us the expense of dredging in the Clyde?—The least expense is about 8*d.* per cubic yard; and the greatest about 1*s.* to 1*s.* 3*d.*; it is according to the nature of the material to be dredged, and the distance of depositing it.

536. (Mr. *Hume.*) Can you state the aggregate amount raised by dredging from the bed of the Clyde in the six years you have alluded to?—I will furnish an abstract of the whole of the results. (*For which see Appendix,* No. 3.)

537. (*Capt. Beaufort.*) Have you blasted any of those whinstone boulders?—No, the bell generally raises them.

538. (Mr. *Hume.*) What is the largest size of any of them?—From four to five tons. They are bored on each side, small lewises put in, chains fixed and raised up by the machinery of the bell. Boulders so large as five tons are raised in this manner from the bed of the Clyde.

539. Where do ships get ballast at Glasgow?—There is generally ballast laid down on the quays, and that ballast goes away in vessels again.

540. (*Capt. Washington.*) What is the material you dredge up chiefly?—Fine sand, coarse sand and gravel, mud and sand mixed, clay, running sand, and mud and sludge.

541. Do you consider it to come from the upper country, or from the sea water chiefly?—From the upper country, and the sewers of the city.

542. (*Capt. Beaufort.*) No shell sand amongst it?—It is destitute of sea-shell sand as far down as Bowling. The sand depositions at Bowling contain minute fragments of coal, which announce that it has come from the higher part of the river down to that point.

543. (Mr. *Chapman.*) What proportion does a cubic yard bear to a ton?—I think on an average in the Clyde, from 18 to 20 cubic feet, is equal to a ton. I have a book in which I have entered the number of cubic feet to the ton, which I had found the various strata to contain along the Clyde; wet and dry pressed and loose. It is not here, but I will furnish it if required.

544. (*Capt. Beaufort.*) With respect to your opinion that the injury that occurs to any river from cutting off any of the tributary streams, are there no cases in which it might be useful to direct the channel of the river, even at the expense of cutting off a considerable portion of the salt water?—In general I think any operation of engineering that shall prevent any portion of the tidal flow from ascending up any auxiliary stream, would be injurious to the scour.

545. Will you state the principle on which you found that opinion?—The principle is, that anything which would diminish the quantity of tidal flow, I should think would be injurious to the scouring power, and to the navigation.

546. Then you make no exceptions to that principle at all?—I am not prepared at this moment to make any exceptions. But if the question be to improve by straightening the crooked or winding channel of a navigable tidal river, in making it more direct, shorter, and easier to navigate, I would not hesitate to recommend such an improvement, even although it should abridge a small portion of the water area; such for example as cutting a direct and wide channel from the town of Belfast down to the deep sea, substituting in this case a straight and shorter channel for navigable purposes to a crooked and lengthened one. All such cuts in my opinion should be trumpet mouthed, gradually increasing in width from the upper part where the cut would commence down to the lowest where it would terminate at the deep sea; and such cuts might even sometimes be made to such a width as to contain an area nearly equal to that of the old crooked channel, thereby losing none of the area of the tidal water surface, and again cases may occur where gentle and easy bends might with great propriety be substituted for direct cuts, thereby lessening the expense, and still preserving all the necessary facilities required for navigation.

[*The Witness withdrew.*]

The Lord Provost of Glasgow and Others.

The Lord Provost of Glasgow,
Mr. *Charles Gray,* Deputy Chairman of the Clyde Trustees,
Mr. *Angus Turner,* Secretary to the Clyde Trustees, and
Mr. *James Walker,* Vice-President Inst. Civil Eng., F.R.S.
} Examined.

547. *Chairman.* (To the *Lord Provost*). You have read the evidence of Mr. Bald?—I have.

548. Is there any information you can give the Commission with regard to that evidence?—I considered it necessary to consult Mr. Gray, as I am simply the *ex officio* chairman of the Clyde trustees, but the principal details more immediately fall under the charge of the deputy

chairman, and the committee of management; and I must refer the Commissioners to Mr. Gray and Mr. Walker, who are now present.

549. (Mr. *Godson*) (to Mr. *Gray*). Are you the deputy chairman of the Parliamentary trustees of the river Clyde?—Yes.

550. Are you also the chairman of the committee of management?—Yes.

551. How long have you been so?—I have been a member of the Trust since November, 1841, and chairman of the committee of management since November, 1843.

552. Under what Act of Parliament is it you now act?—The third and fourth Victoria, chapter 118.

553. During the time that the improvements have been going on in the Clyde, what gentlemen have you consulted as engineers?—Before I was a member of the Trust, the eminent engineers of the day were consulted, including Mr. Smeaton, Mr. Golborne, the late Mr. Rennie, and Mr. Telford.

554. Who is your present engineer?—Mr. James Walker of London.

555. Are there any plans for the improvement of the river, made by Mr. Walker?—There were plans made by Mr. Walker when the Act of the Third and Fourth of Victoria was obtained, in 1840.

556. Has that plan been worked by, or has it been modified?—It was modified to some extent.

557. By whom?—The modification was sanctioned by Mr. Walker.

558. Have you any resident engineer?—Not at present. Mr. William Bald was the resident engineer and superintendent until about a month ago.

559. Have you not yet appointed any successor?—No successor has yet been appointed.

560. In whose care is the river in the place of Mr. Bald?—Mr. Bald had a deputy, Mr. M'Conochie, under whose charge the operations are at this time.

561. When Mr. Bald left you, was there any report made?—Yes.

562. Have you got that report?—Yes.

563. Will you hand it in?—I will. (*The Report was handed in.*)

564. Is there any railway about to be made near Glasgow?—There are several railways projected in the neighbourhood of Glasgow.

565. Are there any that will interfere in any manner with the Clyde river?—Yes; one is the Glasgow Junction Railway.

566. Have the trustees had any application made to them respecting that railway?—They have had application to know whether they would dissent or assent to the scheme when it was first brought forward.

567. What did they resolve to do?—They resolved to oppose it.

568. What have they done?—They presented a petition to Parliament against it, and have taken the requisite steps to oppose it in Committee.

569. When you speak of the opposition, and that a petition was presented, you mean to Parliament?—Yes.

570. Was any thing done in the way of taking advice at Glasgow, or the opinion of the people?—The opinion of Mr. Walker was asked, but has not yet been received, as to the Glasgow Junction Railway; it was resolved to oppose it in Parliament.

571. Has the opinion of Mr. Walker been requested respecting laying rails on the quays generally without relation to any particular part?—In conformity with a resolution of the 8th April last, the opinion of Mr. Walker has been asked.

572. Has any answer been received?—Not yet.

573. Have any instructions been given to Mr. Walker?—Instructions have been given to Mr. Walker in the printed letter which is now handed in.

574. There have been two general meetings of the Clyde Trustees, held on the 1st and 8th of April, in relation to the proposed railways. Have the minutes of those meetings been submitted to Mr. Walker?—Yes.

575. Have you the minutes of those meetings?—I have handed them in as part of Mr. Walker's instructions.

576. Have you made any arrangement respecting the waterworks at Glasgow?—At present, by the Act of 3rd and 4th of Victoria, the trustees are bound to maintain the water level for these waterworks.

577. What is that level?—I cannot exactly state the level above low water.

578. Where was the old weir that supplied the waterworks before the last Act of Parliament?—At the Glasgow or Jamaica-street Bridge.

579. Where is the new one?—At Stockwell-street Bridge.

580. Have you any intention of removing the weir higher up the river?—There is a Bill now before Parliament to effect that object.

581. How far higher up the river is it proposed by that Bill to put the weir?—About 1,100 yards; about 140 yards above Hutcheson-Town Bridge, to maintain the water at the same level as at present.

582. (To Mr. *Turner*.) Could it not be removed higher up the river than that?—It could not at present. It would injure other factories; two or three of which are secured in their rights by statute.

583. (Mr. *Hume*.) Is it a supply of water that is secured to them, or the locality of the weir?—It is rather a supply of the water; that is, that in general the level of the water at their works should be secured.

584. If they could obtain a supply of water to that level, do you apprehend there would be any objection to the removal of the weir?—If they and the other factories were to obtain that supply, I do not think there would be any objection to the removal of the weir.

The Lord Provost of Glasgow and Others.

May 7, 1845.

585. Are there any other parties who would object to it?—A great many in the upper reaches of the river. I suppose not less than 10 additional factories along the banks.

586. Are all the factories equally secured by statute?—No, only two, in addition to the water company.

587. Then the objection of the others might depend on other grounds altogether?—Yes.

588. Are the waterworks' rights dependent on statute?—They are.

589. Are you able to say whether they would have any objection to remove the weir, provided they had a supply of water higher up?—I believe they would have none whatever.

590. (To Mr. *Walker.*) What height is it proposed to raise the water at the Hutcheson Town Bridge?—Giving a comparison between high and low water I will say that the water will be placed to such a level as to support the low water of the river before the Clyde improvements began below the bridges.

591. How much lower does the tide fall since those improvements in the Clyde took place than it did before?—From 2 to 3 feet.

592. Then the weir if established would stop the flux of the tide till it rises above the level?—Yes.

593. How high above that does the tide flow?—Above two miles, but the flow is very small.

594. Up to that extent the water may be impeded?—Yes, an impediment to the ebbing of the water.

595. And to the scour?—I have always been of opinion that the tide has little if any thing to do with the scour there at all.

596. Will not that portion of the water obtained by the weir if allowed to run tend to carry off any deposition in the harbour below it?—Yes, it is nothing but a tendency; the practical result I have always considered has amounted to nothing. The tendency I have always been desirous of encouraging, because I like to see a tide go up and return as far as it possibly can. I have always been of opinion, and I have so stated in a variety of cases, that the state of the river at Glasgow did not at all depend on the tide, but on the river freshes.

597. Does not every fresh tend to bring down water and deposit in the harbour?—It brings it down, but it carries away a great deal more matter than it brings down.

598. If this would tend to prevent the scour of any portion of the ebb, will it not to that extent also lessen the scour?—That would be its tendency. The tide has so little to do with it that when there is a fresh in the river, the tide is not sensible even at Glasgow.

599. That is while the river is full of the fresh?—Yes, the tide never runs upwards. The velocity due to the tide in the river immediately below Glasgow is not, perhaps, (I am speaking from recollection,) one mile per hour, the velocity due to the fresh is from four to five miles per hour, therefore I consider that so high up as that, the river or fresh water is the only scour.

600. (Mr. *Godson.*) That being your opinion, are you also of opinion that there should be no such thing as a weir in the river at all?—Yes. As there is a certain quantity of water coming down, and that quantity must go from the upper part of the country down to sea, it does not follow that the scour should increase as the depth increases; quite the contrary, because from the upper part of the river above where the weir is, the velocity is very great indeed, because the section is small; but when you get below Glasgow Bridge, where the operations of the Clyde trustees have made a very large spacious river, the velocity of the fresh is very much less.

601. Is or is not the improvement of the river impeded by having any weirs at all on the river?—I have already said that in that part the tendency is so, but I say that practically it has not that effect as regards the scour in the river.

602. (Mr. *Hume.*) What is the depth of the water in the weir at low water?—On one side of the river there is no depth at all, on the other there is a gully caused by the weir, and the bridge, which is as much as fifteen feet deep, there is an immense hole. Below that again, there is, as there always is in such cases, a rise, or bar, and then at low water below Stockwell-street Bridge the whole river almost, except just the narrow part, is dry land. Gentlemen who have seen the Clyde at low water are aware that immediately above Glasgow Bridge, until the Glasgow trustees began to deepen it, at low water, the river was confined to a very narrow width.

603. Is not the existence of a weir to create these deep holes and banks afterwards an injury to the navigation?—Yes; but until very lately there has been scarcely any navigation up there at all. I have been very desirous if it could be done, (and I am quite ready to take professionally the whole responsibility of what is done upon myself,) I was very desirous to get this weir removed up a great way higher and designed that place at Dalmarnock.

604. Is not that an object most desirable to be effected with a view to improving the general navigation?—Yes. If that were done and the river deepened, then the navigation of that particular place would be improved.

605. If that weir was removed and the same means applied to deepen the river from the bridges upwards to Dalmarnock, would not the navigation of that portion of the river be improved?—Yes. There would be navigation then where there is none now. It would, in fact, be a very large basin and dock, and would extend the harbour of Glasgow up to the place where the weir would be.

606. Is not that a most desirable object to be obtained for the navigation above the bridge to improve the harbour if by arranging with other interests that can be effected?—The navigation above the bridge could only extend to the navigation of that pool, or dock, or basin formed by it, and the parties who will receive the benefit would be the owners of the property adjoining. As regards the improvement of the river below the bridges I have already said that practically I think it would have no effect.

607. Might not barges go up where now they do not go?—Certainly.

608. Would not that extend the length and accommodation of the harbour, leaving the centre for large ships, while the smaller boats and vessels might go above?—Yes, and that I have recommended; but I would say, that to do that would be a very important, and a very large measure of itself. It is not only as regards the waterworks, but the river being kept up to its present level, if the whole weir were removed, and the fresh to come down, it would scour the bottom of the river to a very great depth; that scour would go up as far as any other point at which you place the weir, and the effect of that would be to widen and to increase the river there, and to bring in the banks, and one of the probable effects would be the destruction of Rutherglen Bridge, which is above it. Still I should like a new bridge built where Rutherglen Bridge is, with the piers much deeper than they are, and I should like everything done which would allow a free ebb and flow of the greatest possible extent, but I am quite prepared to say most sincerely that advising it as I at first did, I was perfectly sure that the trustees of the river Clyde could not carry it in the measure now before Parliament, that they would have failed in their Bill altogether, if they had attempted to do what is now proposed. They removed it first from Glasgow Bridge up to Stockwell-street Bridge, and they are now in the way of removing it again from Stockwell-street Bridge, up to above Hutcheson Bridge, and the time may come when they may have the means of carrying it higher.

609. If the plan be a good one to clear the navigation to the utmost extent of the tidal flow, what is the opposition you contemplate?—The opposition is the water-works, Rutherglen Bridge, the supply of water to the manufactories for which pipes are laid, and the effect on the property on the banks of the river. I think after what I have already said, I need not repeat that that which is called a weir is simply to keep up the river in its old state.

610. The water, in fact, prevents the improvement being made above which has been made below, in respect of deepening the harbour?—Yes.

611. Do you see any objection, except that of the bridge, to the clearance being made, provided the water-works and companies can be supplied with water from the high sources of Dalmarnock, to which you have alluded?—I see no reasons but those I have named.

612. Have you ever contemplated any substitute to supply those water-works and manufactories, so as to enable you to carry out the improvement in the bed of the river by the removal of the weirs which you have stated to be desirable?—I have.

613. Any estimate?—There was no estimate made of it; it never got that length.

614. What was your plan?—The plan was to have a large pipe carried from above the weir that would then be at Dalmarnock, across a neck of land immediately down to the protected factories. I have already said that a weir made at Dalmarnock would supply the Glasgow Water-works as they are supplied at present. Then the Cranston Hill Water-works would either be supplied through this pipe, or (which I think would be a better plan), they might be demolished altogether, and their power added to the present Glasgow Water-works, so as to make one great establishment above Dalmarnock Bridge. I contemplated both plans, and did what I could with the engineer of the Company, to endeavour to arrange such a plan, but I found the opposition to it so great, and the objection so formidable, that I recommended the trustees in the present Bill not to include so much.

615. Is there any legal authority for erecting a weir at Dalmarnock?—No, not at present.

616. Then what necessity would there be for erecting one at all there?—The Glasgow Water-works could not be protected without erecting one.

617. That would be to supply water for the works?—Yes; the water could not be kept up.

618. (Mr. *Godson.*) (To Mr. *Gray.*) Do the trustees look forward to the ultimate removal of all the weirs on the river?—They contemplate the possibility of that.

619. In what way do they contemplate being able to do it?—They contemplate at some time to do it in the manner Mr. Walker has named.

620. Have you any information to give respecting Newshot Island; what difficulties have you found?—It is understood that the bottom of the south channel is rocky, and parties having property along the north side of the river would object to the navigable channel along their property being shut up or changed, and the further expense, probably 8000*l.*, would be much more than any advantage that would result from it.

621. (Mr. *Hume.*) Would not the river be almost straightened by taking the south channel instead of the circuit to the north of Newshot Island?—The channel would be straightened, but I would rather refer that question to Mr. Walker.

622. (Mr. *Godson.*) When you say it would interfere with the property, is it property that you are alluding to above or below low-water mark?—Above high-water mark.

623. When you speak of dealing with the river, have any persons claimed to put anything into the river so as to have vested interests in it?—They claim the land formed by dykes that were made long since.

624. That is what you mean by the word property?—Yes. (Mr. *Turner.*) It should also be mentioned that the trustees lately proceeded to remove one of the old dykes below the south channel at Newshot Isle, and the immediately adjacent proprietor objected to that. He held that the dyke, having been there for a period of upwards of 40 years, the trustees had no right to remove that dyke; that he had a vested interest in the continuance of the dyke, because the land was making up behind the dyke, and increasing, in this way adding to his estate, and the trustees rather than try the question allowed the matter to remain for the present in abeyance.

625. (Mr. *Hume.*) (To Mr. *Turner.*) Was not that dyke put in originally to improve the navigation of the river?—To improve the north channel.

626. If it were found that instead of improving it deteriorated it, have not the Commissioners or trustees, the power to remove that which they put in?—I think they have in point of law.

The Lord Provost of Glasgow and Others.

May 7, 1845.

627. (Mr. *Godson.*) Do the proprietors of the bank say they have not?—That is the bone of contention.

628. (Mr. *Hume.*) Has any opinion been taken from any legal authorities as to that vested right claimed by the proprietors of the south shore?—I should mention, with reference to the rights of the land-owners at this place, that when the last Act was obtained, Mr. Campbell, of Blythswood, the proprietor of Newshot Island, contended that the operations on the river would have the effect of washing away the banks of the island, and there is a set of clauses inserted in the existing Act which protect the banks as belonging to Mr. Campbell, thereby, so far, recognizing and strengthening the right Mr. Campbell conceived he possessed as an adjacent land-owner. It was recognizing by statute the right of the land-owner to access and protection to his banks.

629. Did that statute give him any right to go into the centre of the stream?—The legal difficulty I conceive is this, that as the navigable channel for a long period of time, from the earliest date almost, has been into the north water-way; and the question is, whether, in point of law, the rights of the public to the southern channel may not be lost for navigable purposes; whether it has not become merely an inlet of the navigation.

630. Has any legal opinion been taken on the subject?—Not on that identical point.

631. (*Chairman.*) Has any legal opinion been taken as to the right of the proprietors of the adjoining soil to the constantly accumulating land?—That question is fixed to a great extent by the statute. The right of the land-owner to the soil extends to the north and south of the dykes, respectively, on both sides of the river. Previously to the passing of the Act of 1840, there were several questions depending between the trustees and the land-owners. The question first came before the Court of Session, and then came by appeal to the House of Lords, and the House of Lords held that the Clyde Trustees were entitled, for the purposes of the navigation, to the land which formerly constituted a part of the bed of the river. That was so decided, but there were specialties in the case referred to, connected with the title of the parties to the land which so far aided the general argument of the trustees, and the proprietors contended that the decision in that case could not rule the other questions. We were still involved in litigation with the proprietors in relation to the several interests of the different proprietors along the banks. As the general question, it was contended, could not be held to be fully adjudicated, they appealed to Parliament; and the Clyde Trustees by the interposition of Parliament, during the dependence of the Bill of 1840, and with a view to get forward with the measure, consented to a medium course; and in regard to a large portion of the land-owners they made a compromise, by which the trustees were to be entitled to take the land within the ancient alveus of the river required for the purpose of their works on paying one-half of the price.

632. Then, by that Act, I understand you that the trustees gave up in fact their own right, to avoid opposition?—They conceived that the opinions they obtained from lawyers were so doubtful that they could not find themselves justified in involving the funds of the navigation in expensive law suits; seeing the amount at issue was not very great altogether, they thought it preferable to make a compromise as suggested by the Committee on the Bill, and to give up the one-half of the price, whatever it might be. In consequence of this arrangement the Commissioners of Woods and Forests came forward, and they said that if there be any compensation due to private parties at all it was due to the Crown, and there is a very stringent clause inserted in the Clyde Navigation Act recognizing the rights of the Crown, and reserving entirely the claims of the Crown to the property situated within the ancient alveus of the river. Since the date of this Act of Parliament we have had several jury trials, in which the value of this portion of property has been ascertained. The trustees, under the provisions of the Act, consigned the value so ascertained as in a question between the trustees and the proprietors. The Commissioners of Woods and Forests appeared in the judicial proceedings, and claimed the price of the alveus portion of the consigned land, and have been successful in these proceedings. In point of fact the Woods and Forests are now in possession of funds to the extent of about 1700*l.*, money so acquired, being the price of the one-half of the alveus adjudged by the jury as applicable to the interests of the proprietors on the footing of the statutory compromise being effectual against the Crown. The Woods and Forests have said in our negociations with them that in so far as regards the one-half which the trustees were not bound to pay for, they would exact no price from the trustees, but only prevent private parties, in consequence of the arrangement in the Act of 1840, benefiting at the public expense by taking a price for land which the Woods and Forests conceive not legally to belong to them, because they contend that if it does not belong to the Clyde Trustees it belongs to the Crown.

633. Do not those decisions that you have now stated, and the measures that have resulted from them, substantiate the right of the public, in the name of the Crown, to the alveus land, formerly covered with the tide flow?—I think they virtually do.

634. If these rights of the Crown have been so substantiated, why did the trustees interfere to prevent portions of the dyke being removed, which were considered by the engineer to be beneficial to the navigation?—Mr. Bald, looking to the state of the river, thought that that portion of the dyke at Newshot Island might be beneficially removed, and he did suggest to the committee of management the removal of the dyke. Mr. Walker was not then consulted upon that point. The trustees, however, knew that Mr. Walker considered that dyke was by no means essential to the navigation. It is a half-tide dyke; it did not present any material obstruction to the flow of the tide upwards, the flood tide gets easily through that dyke and above it, and we have the full benefit of the flow of the tide notwithstanding the dyke. The trustees are not solicitous of trying mere abstract questions of law with proprietors, and getting into disputes with landowners, if they can avoid it; their policy is to live in peace with the landowners if they can, and they did not think this was a question involving essentially the interests of the river,

and they thought it more suitable for a public body of trustees dealing liberally with landowners along the banks, not unnecessarily to try questions of this sort; and as it did not form a material portion of their works, they rather left the matter in abeyance. There is no acquiescence on the part of the trustees, but they did not think it a question which justified them in going into a court of law.

635. Did not the resident engineer give it as his opinion that the navigation would be benefitted by removing that, and did he not actually commence by removing a portion of the stone?—He did certainly give his opinion, but the trustees were also advised by higher authority that it was not essential.

636. You say reference was not made to Mr. Walker; to what occasion do you allude?—I mean on that identical occasion reference was not made to Mr. Walker; but the Act of 1840, only passed a few years ago, and we were quite familiar with the questions as to Newshot Island. We knew Mr. Walker's opinion intimately.

637. Did not Mr. Henderson, the proprietor of the land adjoining, remonstrate with the trustees, and did they not, upon that remonstrance, or after that remonstrance, stop the proceedings?—They did not proceed to try the question with Mr. Henderson in a court of law.

638. Did they not prevent the engineer from going on with what he had begun?—Certainly. The trustees must not be supposed to have sacrificed the interest of the river; because I would mention, in explanation of their instructions to the engineer, that they did not conceive it to be a question that justified them in raising unnecessarily a legal question with a landowner about a dyke not material to their works.

639. Do you not consider the removal of every obstacle to the flow of the water upwards, of consequence to the general navigation?—More or less.

640. Do you not consider it would have been the duty of the trustees to remove an obstruction that might have given perpetual improvement?—In the abstract, I should say unquestionably it would; but every case of that kind depends on the importance of it.

641. (Mr. *Hume.*) (To Mr. *Walker.*) Are you aware that Mr. Bald, the resident engineer, began to remove a dyke on the west side, with a view of promoting the flow of tide in that direction?—Yes.

642. Do you consider that the removal of that, with the view of making the channel to the south side of the island, instead of the north, would have been beneficial to the general navigation of the Clyde?—If the change could have been effected from the north to the south side entirely, of course it was right to begin it; but it was extremely wrong in Mr. Bald to begin it, for two reasons, one was, that he had no orders to do it; and another was, that at the very time he was doing it, he was doing an injury. Unless it was previously resolved to change the channel from the north side to the south side, the current of the river could not support a channel on both sides, and therefore, by removing the dike, and allowing the scour of the river to come into two directions, in place of one, the effect was to allow the chief channel to silt up. The question will come, therefore, to this, whether the trustees of the River Clyde did wrong in making the northern channel the navigable channel, rather than the southern side.

643. (*Chairman.*) Are you of opinion that the trustees exercised a sound discretion when they prevented Mr. Bald from carrying on the work he had begun?—I am.

644. (Mr. *Hume.*) Did they consult you upon that occasion?—Mr. Bald was sent up to me I think about that time. I have a memorandum in my hand, which was made in August, 1839, when Mr. Bald was present with me. These were instructions that I gave to Mr. Bald when he came up to me.

645. Was he directed to put himself under your instructions?—He was directed to come up to me for instructions, that was in 1839.

646. (To Mr. *Turner.*) Was that after his appointment as resident engineer?—Yes.

647. (To Mr. *Walker.*) What is the memorandum?—"Newshot Island. Mr. Bald thinks the question of the best course for the navigation here should be investigated; that the south course would be 200 yards shorter than the present course, north of the island; that there being a rocky bottom, is an objection in the south channel. Mr. Walker stated that the subject had been investigated by Mr. Logan, and that his (Mr. Logan's) reasons, (Mr. Logan was the predecessor of Mr. Bald,) must have appeared to him (Mr. Walker) satisfactory, although he (that is myself) does not remember all. Mr. Rennie, and Mr. Telford, as well as Mr. Logan, having preferred the north channel, was adduced, as a proof of the north being the better. Mr. Walker, however, agreed in the importance of the matter, and to Mr. Bald's investigating the facts."

648. After that interview between Mr. Bald and you, did Mr. Bald investigate as then advised?—I think he did.

649. Did he make any report to the Commissioners on the subject?—I do not remember what report he made to the Commissioners, nor do I know the fact.

650. Did he make any report to you?—I think not.

651. When it was left to him to investigate, do you not think the trustees ought to have consulted you after the recommendation he gave to them, that the channel would be greatly increased by adopting the south instead of the north?—I have no doubt the trustees asked my opinion.

652. (To Mr. *Gray.*) Has not the Clyde been greatly improved and deepened during the time Mr. Bald has been engineer?—Not materially deepened I think.

653. Are you aware whether there is any increased depth of water in the harbour, or in any of the shoals below that opening of the river, since Mr. Bald's appointment took place?—Considerable, more particularly at Port Glasgow Bank; the harbour is not much deeper.

654. Are you prepared to show it is not much deeper. Has there not been a depth of water exceeding three feet along the quays?—It is about two feet.

The Lord Provost of Glasgow and Others.

May 7, 1845.

655. Do you speak from the examination of any other engineer, or from the report of Mr. Bald?—From what Mr. Bald has told me himself.

656. Has he not reported in writing the depth of water that he has gained?—Not exactly.

657. (Mr. *Chapman.*) Does he not attribute it to dredging?—The deepening of the Clyde is owing to dredging.—(Mr. *Turner.*) The fact is the only soundings that have been taken, at least the only soundings the trustees would be disposed to be responsible for, in any form, were those taken at the time of the passing of the last Clyde Navigation Act. They then got the river sounded by a person in whom they had the utmost confidence. Those soundings were proved before Parliament, being taken with great care. Since that period no regular soundings have been taken, and all that can now be stated as to the improvement since Mr. Bald became engineer is just simply that the trustees have been exerting themselves to the utmost in making every possible improvement; they have been sparing no money that was at their disposal to accomplish this; and Mr. Bald has been the instrument, under their direction, in accomplishing that object, but he had little more to do with it than I might be said to have had in writing the minutes of the trustees, carrying out resolutions, with a view to the improvement of the river.

658. (Mr. *Hume.*) He has been executive officer?—He has been superintendent under Mr. Walker's directions.

659. Are there any minutes of the trustees directing him to remove the boulders from any portion of the river?—At the meetings of the Committee of Management Mr. Bald usually attended, and they do not think it necessary in carrying out the details of the works to make minutes in all cases instructing Mr. Bald to do so and so. The course is this: I recollect, for instance, that Mr. Burns, who is one of the largest steam-boat owners in the Clyde, on one occasion complained to the Committee of Management that the bank at Port Glasgow was an obstruction to steam-vessels, and he submitted to the trustees that Mr. Bald should send down the dredging-machines, and Mr. Bald was instructed by the Committee, on Mr. Burns' motion, chiefly, to effect that improvement. It was done under the immediate instructions of the Committee of Management, emanating from Mr. Burns chiefly.

660. Take another example:—opposite the end of Newshot Isle, where a collection of large boulders existed. Were there any minutes of the Board directing him to remove them?—In relation to these shoals in the river, they are generally brought before the Committee in this way: the members of the Committee themselves are constantly going up and down the river, and meeting with steam-boat masters, and hearing complaints as to particular inconveniences in the river. When such complaints are made, one member or another brings the matter before the Committee of Management. Mr. Bald is instructed, if there is a greater shallow in one place than in another, to place a dredging-machine upon it. I do not remember that Mr. Bald of his own accord, without some proceedings of that sort, or without first reporting the circumstances to the Committee, ever has undertaken any work of consequence. No doubt if Mr. Bald did see a shallow he would mention it, but the Committee going so frequently up and down the river, and communicating with the steam-boat owners and masters, and those who were suffering from inconvenience of any kind, they, themselves, are in the practice of bringing such matters under consideration of the meetings, and the engineer's attention is directed to the most pressing portions of the river accordingly.

661. Has not the engineer reported annually, and from time to time, to the Commissioners?—Latterly he has been reporting monthly.

662. From the time he was first there has he not been in the habit of reporting?—There has been several reports.

663. Are we to understand that the Board were rather directed by the anonymous kind of information received from masters of ships than from the written opinion of Mr. Bald?—I do not state that they were directed by any anonymous information. I stated that matters of that description, as for example, the removal of a particular shallow, or the bank at Port Glasgow, or the removal of boulders, that these facts often came directly to the knowledge of the Committee of Management from persons who were suffering inconvenience from them. The owner of a ship might complain, "My ship struck on a shallow." That is immediately brought before the Committee, and they ask Mr. Bald how is this, you must send a machine to get the shallow removed. It is not done from any anonymous information, but from the statements of parties suffering from the inconvenience.

664. Do you know at any time of the Board having forbidden the removal of the boulders?—No.

665. Look at that document, whose writing is it? (*handing the same to the Witness*)—Mr. Spreull's, the late treasurer.

666. Had Mr. Spreull, as treasurer, the power of interfering with the work of the engineer?—None whatever.

667. Are the diving-bells employed to remove boulders?—They are.

668. Is not that, therefore, an interference to prevent that very work being carried on?—It would appear to be so, but how he came to give these instructions I cannot conceive. The only explanation I can give of it is, that I remember the trustees, in consequence of enormous purchases of land they had made for the purpose of enlarging the harbour, and having had several jury trials, and in one of them, I think, they paid as much as 58,000*l.* under one verdict. The trustees came in this way to embark in a very heavy expenditure, and much larger than they anticipated at the period these trials were instituted, and I know there were some members of the Finance Committee who were very much concerned about the financial condition of the trust, and I remember perfectly that they had under their consideration the expediency of limiting their operations until they saw their way a little more clearly, as to their means of meeting these engagements. I do recollect that I attended several meetings of the Committee, where these

things were discussed in 1842, and Mr. Spreull being treasurer, and present at these meetings, I think he is extremely likely to have received some hint from the Committee, that the expenditure must be reduced as much as possible, and that this writing must have emanated from some motive of that kind on the part of the Committee, by way of seeing that the trustees did not exceed the amount of their pecuniary resources. I believe that memorandum must have been handed to Mr. Bald, in consequence of a desire on the part of the Committee to proceed prudently in the execution of the works.

669. The object of my question was to ascertain whether any Minutes were entered by the Committee of Management or Board, directing Mr. Bald to proceed to improve the river at any particular spot?—There may be Minutes in special cases; Mr. Bald did not always receive his instructions in writing; in cases of magnitude, I think it is probable he received his instructions in writing.

670. Have any of his reports respecting improvements for the upper part of the river especially been received? Do you recollect the Report made by him recommending improvements above the bridges?—I think there are several.

671. Do you recollect any Minutes, or any measures taken in consequence of them, to carry them out?—I do not think it was in consequence exactly of Mr. Bald's reports. He did report upon these operations, but I do not recollect any single improvement suggested by Mr. Bald, taking place without its having been approved of directly or indirectly by Mr. Walker. I cannot trust my memory to state that any of these reports were adopted by the trustees.

672. You say without being referred to Mr. Walker,—within these six years, after the plan was drawn by Mr. Walker for the improvement of the Clyde which Mr. Bald was to carry out as executive officer; how often have you consulted Mr. Walker?—I could not trust my memory in stating how often.

673. Have you ever once consulted him?—Yes; Mr. Walker was consulted within the last three or four months about the erection of walls.

674. (To Mr. *Walker.*) Since you gave Mr. Bald the plan upon which his operations were to be founded, how often have you been consulted by the trustees as to further improvements?—Frequently as to improvements, but not as to the particular mode of carrying out what may be called my plan. But when I say "my plan," I am presuming too much, because it is due to an individual (Mr. Logan) who is now dead, to say that he had projected the lines of improvement before I was consulted by the trustees. I modified Mr. Logan's lines: I came to Parliament with those. After that the trustees, without Mr. Bald, considered that the lines might be abridged within what I had proposed. I went down on one or two occasions, and arranged the whole plan with Mr. Bald, and since that time, the particular deepening I have not been consulted about at all. I believe Mr. Bald acted under the immediate direction of the trustees, but the trustees, in order to save expense, have not called on me, but in all their improvements upwards which had not been defined I have always been consulted.

675. Is it your opinion that towards improving the Clyde all impediments to the flow of the tide upwards should be removed as much as possible?—Certainly not as to width, because to remove impediments to the width would be to bring the river back to what it was before the improvements were begun at all. Perhaps the Commissioners are aware, and in fact it is now almost proverbial, that there is no river in, perhaps, I may say the world, that has been so much improved as the river Clyde has been; that when the greatest man of his day, Smeaton, was employed, there were only some three or four feet at the high water of a neap tide at Glasgow; that by following the directions of Rennie and Golborne, and afterwards Telford, which was to contract the river and to remove the shoals and then to trust to the freshes of the river deepening the channel of the river, confining it in width, that in that way the navigation would be improved. That is the great principle that has been adopted in the improvement of the Clyde, and it has been done with very great success; therefore to remove the banks and allow the tide to have its full range up again, would be to undo all that has been done. The river would naturally come back again to its former state. That would be the tendency, but I think that the perfection of the river Clyde is this, that a deep channel is formed because the channel is uniformly narrow. It does appear to me that the river was made too narrow, that Mr. Telford's advice on that was to narrow it beyond what afterwards appeared to be beneficial; but that, like many other things, is done by degrees. If the river Clyde had been made at first as wide as the trustees now propose to make it, the depth of water would not have been obtained, and the trade would not have come up the river which has enabled them now to find a revenue and to widen it again, because it will not support its present width without an annual expenditure in artificial deepening. When it was so narrow, it did nearly support itself, but I have told the trustees that by this widening which I have recommended to be done, they must expect a considerable expense in artificial deepening.

676. (Mr. *Godson.*) How much wider is the new widening?—I dare say the navigation will be double what it was before. I have made it as wide as I think the size of vessels require, and yet made it so narrow as to endeavour to make the tide and the freshes keep the river clear with small assistance. When I say the tide and the freshes, I refer to the lower part of the river. I have already said that the upper part of the river is the effect of the freshes only, and I have said in my report that all the dykes in the lower part of the river ought to be made only half-tide dykes so as to allow the tidal water to come up freely, but that in the upper part of the river the tide is of no consequence.

677. (Mr. *Hume.*) Have not part of the improvements in the river been obtained by removing projecting points in the course of the dykes on each side because they protruded into the stream?—Yes.

678. Are we to understand that you do not object to the removal of those portions of the

The Lord Provost of Glasgow and Others.

May 7, 1845.

dike that project and impede the flow of the tide, provided the width which you have considered necessary is maintained?—Yes.

679. During the last six years have not a great many of those projecting points which did give a direction and interfere with the tide, been removed?—Yes, and the river widened. I am speaking now from information; I had not visited the lower part of the Clyde professionally.

680. Are we to understand from you that you consider the improvements to have taken place mainly by dredging, removing banks, and taking away projecting points of the shore on each side that impeded the tide?—Yes, and narrowing the current of the river.

681. At the lower part?—All the way up.

682. Narrowing thereby to increase the current at these spots where it is shallow?—Yes, to increase the current within the part so narrow.

683. And deepening the channel in those parts?—Yes, but I am quite sure that somewhere in the records of the trustees, my opinion will be found, with regard to Newshot Island; and I at once say that I think it would have been, and will be almost a waste of public money, to endeavour to stop up the present channel on the north side, and to make it to the south of the Newshot Island. I say waste of money, because the money required for it in the removal of the stone quarry in the channel would be very considerable.

684. Do you consider that would be the principal objection to opening the southern channel?—The cost of removing the solid stone rock under low water, the deepening of the channel from end to end, and stopping up the northern channel; and there is a length of two miles of property abutting on the present channel of the river, which would have to be stopped up. The owner of that property would, I conceive, have a claim to heavy damages, if the trustees were to take the river entirely away from his property, and give it to the property on the south side.

685. Would not the southern channel if deepened, be a more direct channel for the navigation than the north now is?—It would be somewhat; I think it would be about 130 yards shorter in a length of two miles. I really could not recommend the trustees; I did not consider the merit of the south side to be such as to induce me to recommend the trustees to stop up that channel which Mr. Smeaton, and Mr. Rennie, and Mr. Telford considered the best, and Logan also, and to substitute the southern channel for it, and the northern channel was approved by the Committee according to the plan at the time the Bill was in Parliament in 1840; but I would ask any one to say whether the difference is such as to justify my recommending a very heavy expenditure.

686. You would consider it necessary to ascertain first what the absolute expense would be before you could advise it?—Yes, and I think I did, and I am now prepared to say that the expense would much exceed the public benefit, and the trustees would not have been justified in attempting it. If the section of the south channel made by Mr. Aird be correct, which I have no reason to doubt, the removal of the solid stone rock for half a mile in length, in order to give a sufficient depth, would cost ten times what Mr. Bald estimated for all the work of opening the south channel.

687. (*Capt. Washington.*) Without making the southern channel a navigable channel, would it not be beneficial to take down so much of the parallel dike as would allow the tide to ebb and flow through it?—I do not remember what the level of the parallel dike is, but if the question refers to taking it down, so as to allow the water to ebb freely up and down through it, then I do not agree with it, because as will be seen in a moment, if you allow the tide to ebb freely through the two channels, you divide the power and diminish the water.

688. Suppose the dikes to be half tide or quarter tide by which you would secure in the one case the flow and have the benefit of the entire scour, and at the same time keep the half and quarter of the ebb in the proper channel, would not that be beneficial?—Yes, and I rather think that is so.

689. Are you able to state what your views are as to the possibility of further improvements, so as to deepen the water up to the quay at Glasgow to any extent?—I can only refer the Commissioners to the evidence I gave at great length, and which is printed, and to my report in 1837, and also in 1840, which were transmitted to the Commissioners from Glasgow.

690. I am alluding now to the improvements that have been made in the last few years; after these improvements, I ask whether any thing further can be carried on?—I am not aware of any, if the trustees with Mr. Bald have been carrying on the improvements according to the plans that were agreed to by me some years since.

691. Is there a longitudinal section of the river Clyde from Glasgow to its mouth?—Yes. I would state that while I have been speaking Capt. Beaufort has been trying the difference between the north and south side of Newshot Island, and he states to me it is only 87 yards, in place of 130 yards which I named.

692. (Mr. *Hume* to Mr. *Gray.*) Why is the Glasgow Bridge Bill proposed to be recommitted to day?—Some petitioners against it were not heard in Committee.

693. Do you intend to pay any money from the Clyde towards that bridge, because in the 48th clause it says that the Trustees are to give over above 8000*l*. How is that at all connected with the navigation?—It is proposed under other clauses of the Bill that the navigation shall pay a certain sum towards the erection of the bridge, in consideration of the piers of the bridge being sufficiently deep to enable the trustees to carry on the improvements which they have at present power from Parliament up as far as the Stockwell-street Bridge, and with a view of prospective improvements above it.

694. Why should the trustees pay any portion of that which is intended for improving the navigation?—Returning to the advice under which the trustees have all along acted, Mr. Walker reported as to these three bridges, in the month of September, 1844. He says—"While the weir existed at the Glasgow Bridge, the Stockwell Bridge piers were compara-

tively secure; but the removal of the Glasgow Bridge weir has rendered the sand which formed the bed of the river up to the Stockwell-street weir liable to be washed into the deep pool (the Harbour) below the Glasgow bridge, even if there had been no artificial deepening done to form the upper harbour; and this deepening is in progress." It is the opinion of Mr. Walker that the deepening cannot go on until the piers of the new bridge are founded much more deep than the old one. The old bridge will fall if the deepening is carried on, and the river trustees deem it a fair and just arrangement between the two trustees that the river trustees should pay the additional expense incurred by founding the piers of the bridge sufficiently deep for this purpose, and also the expense of removing the weir from the Stockwell-street Bridge to the distance of 140 yards above the Hutchinson Bridge.

695. Were not the foundations of that bridge strengthened a few years ago at a considerable expense?—In some degree they were strengthened.—(Mr. *Walker.*) The weir at Stockwell-street Bridge was strengthened under Sir John Macneil's and my direction. The principal object of it was a complaint from the water company that it was getting too low, and allowing them to lose their supply of water. It was simply done by driving a row of piles across the river, and that was done under the order of the Court of Session. It was referred to us in consequence of a complaint of the loss of water from the water company, we reported our opinion, and we were ordered by the Court of Session to execute this work: that was done. The great object of it was to keep up the head of water for the water company; but the weir also was strengthened, in consequence of the wash of water being so great that the piers were in danger. I would add, that Sir John Macneil and myself reported 8100*l.* as a fair sum to be paid by the Clyde Trustees to the Bridge Trustees.

696. That they might have an opportunity of improving the navigation?—Yes.

697. (To Mr. *Gray.*) Can you give us a copy of that order of the Court of Session, directing that they were to be run across the harbour?—No doubt it can be furnished by Mr. Turner (who had been obliged sometime previously to this to leave).

[*The Witnesses withdrew.*]

Mr. *Richard Hinde,* } Lancaster Quay Commissioners,
Mr. *William Robinson,* } examined.

698. (*Chairman.*) (To Mr. *Hinde.*) You are one of the Quay Commissioners at Lancaster?—I am.

699. Are you authorized by the Commissioners to appear in their behalf?—I am.

700. Are you a party consenting to the contract with the Railroad Company?—I am.

701. Will you lodge a copy of the agreement with the Commission?—I will.

702. (Mr. *Hume.*) How far below the lowest existing bridge do you propose to have the new bridge?—500 yards.

703. How is that space occupied at present?—By wharfs and warehouses.

704. What depth of water is there at these wharfs?—Not above 2 or 3 feet.

705. What accommodation is there as a port to the town between the site of the proposed bridge and the nearest existing bridge?—The quay comes much below the old bridge, and continues below where the intended crossing by the railway now is.

706. For the landing of goods?—Yes; a considerable portion of that is used. The lower portion is not often used for the landing of goods.

707. What kind of bridge is that to be?—Two arches.

708. To admit of vessels passing under it?—The level we have consented to take is 32 feet above the level of the quay. It will not allow vessels to pass up.

709. (*Capt. Washington.*) What compensation will the Railway Company give for the quarter of a mile of harbour they are about to take towards improving the navigation of the river?—The amount agreed on is 16,500*l.*

710. Upon what estimate is that founded?—Upon an estimate taken for the compensation of the owners of quay property held under a lease, who will receive an amount of injury by depriving them of it, and in the construction of the quay.

711. How much of that money will go to improve the navigation?—None. The original demand was 25,000*l.* for the express object of leaving a margin for the improvement of the navigation, but which the Railway Company would not agree to.

712. (*Capt. Beaufort.*) What was the general intention of the improvements proposed? What did they intend to do to improve the navigation?—Taking off shoals so as to make the river straight to a certain extent.

713. What do they intend to do with the 16,000*l.*?—It will all go in compensation to the private holders of property and to the construction of a quay.

714. What will the quay cost?—Perhaps from 7000*l.* to 10,000*l.*; but I am speaking at random, for I do not recollect the estimates.

715. Will the gas works have to be removed?—We conceive not.

716. (Mr. *Godson.*) When the new quay is built, as your Quay Commissioners propose it, will that new quay afford the inhabitants of Lancaster as much accommodation as the present quay does?—I should think it would.

717. Lower down the river there is at present a quay called the New Quay. I wish to know whether the quay you are about to build under the Act of Parliament will or not be more commodious than that quay that you have got lower down the river?—Very much more commodious.

718. Looking to the navigation of the river, in your opinion, as one of the Quay Commis-

Mr. *R. Hinde* and Mr. *W. Robinson.*

May 7, 1845.

sioners and conservators of the river, would the coming of the railway be any injury to the river?—No; not on the compensation.

719. Your compensation being for the interest of private parties; does the passage of the railway cause any impediment to the navigation of the river, being a less navigable river than it was before for the general purposes of the town?—The height of the bridge does not allow vessels to go under it, and impedes the navigation.

720. Does the impediment of it for 500 yards do any damage to the town?—It does to the property immediately concerned.

721. And that you gave money to?—Yes.

722. After you have paid your compensation, is it any injury to any one?—Except to the corporation, who have a right to have vessels higher up.

723. Have the corporation agreed to it?—I believe they have agreed to it; I am not prepared to say.

724. (To Mr. *Robinson.*) Do you know whether the corporation have agreed?—They have.

725. (*Capt. Beaufort*) (To Mr. *Hinde.*) Is there any reason why the railway should not be carried up on a sufficient level to allow a vessel to pass under it?—I see no reason but the expense.

726. Will not that expense fall on the railway company, and not the corporation?—It would.

727. What is the tonnage of the vessels that come up?—From 80 to 100 or 150 tons; and occasionally 200 and 250 tons.

728. If the railway company were obliged to make their bridge sufficiently high and sufficiently large in the arches to permit larger vessels to go up, that would be a great advantage to the trade, would it not?—It would.

[*The Witnesses withdrew.*]

Adjourned till Friday next, at 1 o'clock.

Friday, May 9th, 1845.

Present:—

Rear Admiral BOWLES, C.B., in the Chair.

Captain Sir GORDON BREMER, K.C.B.	Mr. GODSON, M.P.
Mr. HUME, M.P.	Captain BEAUFORT, R.N.
Mr. A. CHAPMAN, M.P.	Captain WASHINGTON, R.N.

Mr. *Wm. Robinson* and Mr. *Edmund Sharpe.*

May 9, 1845.

Mr. *William Robinson,* and Mr. *Edmund Sharpe,* } Lancaster Quay Commissioners, sworn and examined.

729. (*Chairman.*) (To Mr. *Robinson.*) You are acquainted with the two proposed railways?—I am.

730. Which do you consider will interfere least with the navigation of the river?—The line as originally proposed above the town, would interfere least with the navigation of the river.

731. How high do vessels come up at present?—Nearly to the ruins of the old bridge; they come up to what is called Lawson's Wharf, where they discharge.

732. (Mr. *Godson.*) How many arches has the new bridge?—Five arches.

733. (Mr. *Hume.*) How high does the tide flow beyond the town?—Up to Skirton Locks.

734. What is the distance from the east end of the town to the locks?—A quarter of a mile.

735. Is that quarter of a mile navigated by any sized vessels?—None; they cannot possibly pass the new bridge.

736. What is the opposition of the new bridge?—The lowness of the arches, and the want of depth of water.

737. The tide flows up through these arches up to the locks?—Yes.

738. When were the locks built?—Not in the memory of man.

739. Does the water at all flow over the locks?—I think the tide very seldom if ever flows over the locks; it does not always reach it.

740. Then these locks have stopped the flow of the tide that would otherwise have run up the river?—Yes.

741. (*Chairman.*) Then if the new line of railway should be approved, the new quays and wharfs must be built below it?—They must.

742. (Mr. *Hume.*) From the ruins of the old bridge to the intended line, what extent of harbour will be interfered with?—I should think about 500 yards.

743. What sized vessels come to that harbour now?—At present there are various sizes; vessels varying from 80 tons to 100 and 150 tons, can navigate that portion of the river.

744. Has any effort been made of late years to deepen the Lune River by dredging or any other means?—There has; at Scale Ford efforts were made some years ago.

745. Are you aware that the Quay Commissioners gave their consent to the new line?—I am; I was one of the committee.

746. Has there been another Board elected since the 2nd of May?—There was one elected on Wednesday last.

747. Has that Board come to any resolution respecting this bridge?—I have not heard of any.

748. Have the new Commissioners given any fresh orders?—I am not aware of any; they are elected every three years, and Wednesday was the day appointed by the Act of Parliament. Mr. Sharpe can speak to the election, but there has been no confirmation of this agreement.—(Mr. *Sharpe*.) I know the names of the Commissioners who have been appointed; we have no further communication with them.

749. (To Mr. *Robinson*.) You were two of the old Commissioners?—Yes, and also two of the present Commissioners.

750. (*Capt. Beaufort*.) Have the new Commissioners met since their appointment?—I apprehend not.

751. (*Capt. Sir G. Bremer*.) You, as members of the former Commission, have consented to the new line?—Yes.

752. (*Chairman*.) Will you state a reason for so consenting?—We consider the railway passing in that direction would be more likely to be beneficial to the navigation and the town at large, than by passing in the old line as connecting the railway and the navigation nearer together.

753. (Mr. *Hume*.) Do you take into account that it would stop the flow of water upwards, and might interfere with the depth of the navigation below?—The whole of that question was considered, and the probability of benefiting both the river and the railway.

754. In what way would the river be benefited, if the flow of the tide upwards was impeded by that new arrangement?—It could only be impeded by the piers of the bridge.

755. (Mr. *Godson*.) Is more than one pier to be in the river?—Two piers in the river.

756. (Mr. *Hume*.) What proportion of the water-way would those piers be, taking not only the middle but the side piers?—(Mr. *Sharpe*.) Twenty-four feet.

757. (Mr. *Godson*.) (To Mr. *Robinson*.) Have the inhabitants of the town of Lancaster held any public meeting respecting the crossing of the river, have they come to any resolution whether they approved or disapproved of it?—There was a large meeting, and a resolution passed approving of the new line by the inhabitants generally.

758. Was it a meeting called by the mayor, or was it a common meeting?—A requisition was presented to the mayor, and he appointed the meeting in the ordinary way.

759. Was it numerously attended?—Very much so.

760. (*Chairman*.) In what way do you propose to compensate for the impediment that is thrown in the way of the navigation of the river, by preventing vessels coming, as they have hitherto done, up to the town and alongside the existing quays?—By erecting new quays to the westward of the intended viaduct.

761. (Mr. *Godson*.) Would that be done by you as Quay Commissioners?—Yes.

762. (Mr. *Hume*.) Does the Company's railroad propose any means by which the river shall be deepened?—I am not aware of any.

763. (Mr. *Godson*.) Was any portion of the 16,500*l*., that is to be paid to you as Quay Commissioners, to be laid out in the improvement of the water-way of the river?—After first paying the compensation to the owners of property, and erecting the new quays, any surplus there may be will be applied to the improvement of the river.

764. Do you expect any surplus?—That is so uncertain that I am unable to state. I do not know what juries may give if parties apply to juries.

765. (*Chairman*.) You have no certainty of any surplus?—No.

766. (Mr. *Godson*.) (To Mr. *Sharpe*.) I believe you are an architect?—Yes; and the bridge master of the county.

767. Being an architect and bridge master of the county, will you explain to the Commissioners what will be the effect, either for good or for evil, on the River Lune of this deviation?—I am of opinion that the Railway Bridge will certainly be prejudicial to the navigation.

768. (Mr. *Hume*.) In what way and to what extent prejudicial?—In the first place, in regard to the flow of the tide unquestionably; and secondly, in the circumstance of its cutting off all communication with the present wharfs, quays, and warehouses.

769. (Mr. *Godson*.) Leave out the wharfs and quays, and assume, for the purpose of the inquiry as to the river-way itself, that new quays and new wharfs are erected by the 16,500*l*., we want to know what effect it will have on the water way?—It will have a prejudicial effect; the extent of that prejudicial effect it would be difficult to state.

770. (Mr. *Hume*.) Is there any mode by which, in your opinion, the injury which the new bridge would do to the navigation might be compensated?—By deepening the channel below.

771. To what extent do you consider the channel might be deepened from the bridge downwards?—The whole length of the channel is 6 miles. The bed of the river at that bridge is 10 feet above low-water mark. Any improvement, therefore, of the channel, must necessarily be a very considerable one, and attended with very considerable expense.

772. Has any estimate been made of what the expense would be to deepen it from the mouth up to the bridge?—Yes; a report has been given in, and printed, by Mr. David Stevenson, the engineer.

773. What is the purport of that report?—It recommends the removal of shoals in different parts of the river to a specific depth. I would state incidentally that this report of Mr. Stevenson, and the measures he recommended, were not carried out by the Commissioners. It was considered too great an expense, and the improvement of too uncertain a nature to be undertaken.

774. What Commissioners do you allude to?—The old Commissioners.

775. What is the date?—The date of this report is the 14th of December, 1838. No measures have been taken upon that.

Mr. *Wm. Robinson* and Mr. *Edmund Sharpe.*

May 9, 1845.

776. Tell us what his recommendations were?—To deepen the river. I am unable to tell you to what extent, but I think to an additional depth of four feet in the whole course of the river. I speak rather uncertainly on that point, but the total expense to be incurred for that purpose is 13,200*l.*

777. What depth would that have given you at the new bridge now, at the site of the bridge proposed to be erected, if it were carried out?—A total depth of 16 feet at high-water of ordinary spring tides.

778. What is your highest depth now at spring tides?—I think about 12 feet, but I speak with uncertainty upon that point.

779. Would that depth which is contemplated suit the commerce of the district?—To a very limited extent.

780. What further depth do you contemplate the commerce of the district would require?—At least an ordinary depth of 20 feet at ordinary spring tides.

781. (Mr. *Godson.*) Is it possible to have more than 20 feet up at the new bridge?—I do not believe that the present river is capable of improvement to that extent, because the expense would be so enormous. It is right to state that other measures have been contemplated by the Commission.

782. (Mr. *Hume.*) In preference to deepening the whole channel?—Yes.

783. Has there been any report of any engineer to that purport?—No report has been made, or any expense incurred, or any measure taken with reference to them in consequence of the hope of the Commissioners that they would be able to derive important and valuable information from the Admiralty as soon as they became possessed of the plans that Captain Denham has been preparing of the bay and of the river, and they considered it therefore right to suspend any operations.

784. There has not been a complete survey taken for many years?—No. This survey has had the effect of satisfying many of the Commissioners that the improvement of the present navigation is hopeless to the extent that is necessary.

785. (*Capt. Washington.*) Without Sunderland Point is there any impediment in the navigation to the entrance of the river?—The whole of the outer navigation from Sunderland Point to the actual mouth of the river is so full of difficulty in consequence of the large extent of sand on each side, without any means of protecting the channel, that I apprehend the construction of any works to maintain the channel in that portion of its length would be infinitely more expensive than anything we should have to incur for the whole remaining eight or nine miles within the mouth of the river.

786. (*Chairman.*) Has there been any plan in contemplation for improving the navigation?—Yes; fifty years ago the merchants of Lancaster projected a deviation of the course of the river Lune from the Island Salt Area through the peninsula of land, which lies between Morecambe Bay and the Island Salt Area, westward near the old mill.

787. (Mr. *Godson.*) What distance is that?—Two miles and a half in length.

788. Is the country flat or hilly?—The whole of the country lying between the two points is, with perhaps one exception of 100 or 200 yards, scarcely above the level of high water mark at high spring tides.

789. (Mr. *Hume.*) Into what depth of water will you come in?—Twenty-four feet at low water.

790. If that new plan down to Poulton Ring, which you have stated could be carried out, would the benefit of the navigation up to Lancaster be such as to compensate fully any impediment that the bridge by the new railroad would throw?—It would more than compensate for it. At the same time, it depends upon how the question is put as to how it is to be answered, because, if the whole course of the river were to be blocked up, and the whole of the river diverted into this new channel, there could be no question that it would be most ample compensation; but if the whole course of the river be maintained, and the difficulties of diverting it be found very great, both in regard to compensation for rights and privileges, and in a nautical point of view; if those are to be taken into account, it is impossible to say how far the demand might not exceed in money the advantage to be derived to the town. Probably 100,000*l.* might be required for the works, and in addition to that, a very large compensation amounting to 20,000*l.*, or more to the land owners and for severance.

791. (*Chairman.*) Do you mean to be understood now as speaking of the compensation to the parties whose lands you would take and cut through?—Yes; before coming to a determination on the project which I have mentioned, the Commissioners would be guided by the information, that Captain Denham or the Admiralty may supply. The other project was not to divert the river but to bring this admirable sea channel into immediate communication with Lancaster by means of a railway and docks constructed at Poulton.

792. (Mr. *Godson.*) Would the new line assist in that project of having quays at Poulton, and thus assist the town of Lancaster?—I cannot conceive that it would have any effect upon it.

793. (*Capt. Beaufort.*) Are those docks at Glasson used at all now?—Yes.

794. By whom?—By the whole of that portion of the shipping which is unable to get up to Lancaster.

795. Who do the docks belong to?—To the Lancaster Quay Commissioners, they were constructed by them.

796. (Mr. *Godson.*) Have you a place for landing called the New Quay?—Yes.

797. Is that a place for landing goods and where ships stop when they cannot get to the town?—Yes.

798. (*Capt. Beaufort.*) What is the communication you have now between the Glasson docks and the town of Lancaster?—Not only do we make use of that harbour of Glasson, but the Lancaster and Preston Canal Company have a branch from that harbour to their main line from Preston to Lancaster, and a very large quantity of goods are brought on that

canal up to the town of Lancaster to the north and down to the town of Preston to the south.

799. (Mr. *Hume.*) What class of vessels came to Glasson?—All vessels upwards of 100 or 150 tons burthen.

800. What is the largest vessel that comes there?—North American timber ships.

801. What is the largest that has ever gone into Glasson?—I cannot answer the question.

802. (Mr. *Godson.*) What is the largest that has come up to Lancaster?—Not more than 280 tons.

803. Was this branch down to Glasson originally made to the canal, or was it a branch made to accommodate the town of Lancaster; was it a part of the canal, or has it been made of late years?—It has been made of late years.

804. Was it for the purpose of bringing goods that had come from ships that could not get further up the river to the town of Lancaster; you unship at Glasson, and then come by the canal up to the town?—Yes, both to the town of Lancaster and the town of Preston. The traffic to the town of Preston, I fancy, is considerably more than that which comes to the town of Lancaster.

805. Does that come in through Glasson?—Yes.

806. Then the branch canal was made for the double purpose of coming to Preston and bringing the goods up to Lancaster that could not come by ship?—Yes.

807. For instance, if a 400 tons vessel came to Glasson and could not come further up she unloaded, and then the goods came by the canal?—Yes.

808. (Mr. *Hume.*) If the river Lune was deepened agreeable to the estimate, four feet at least all the way up, would that bring the goods that are principally required at Lancaster by the river?—Before answering that question it is proper to state that we anticipate a very considerable increase of our traffic; that a line of railway is projected to the town of Lancaster, which will be brought into immediate connexion with our port; that that line of railway will enable us to deliver the whole of the produce required in the West Riding of Yorkshire, at one half the price of tonnage charged at the present time from all other ports of Lancashire. Therefore, in order to answer the question properly, I should state, that with that expectation of traffic, I am quite certain that nothing like that additional accommodation would answer the purposes of the port.

809. (Mr. *Godson.*) Do you mean four feet?—Yes.

810. (Mr. *Hume.*) Looking at the present existing traffic between Lancaster and the sea, would that additional depth of four feet be sufficient?—I should be inclined to doubt it.

811. (*Capt. Washington.*) What was the original sum demanded by the Quay Commissioners, as compensation of the Railway Company?—25,000*l.*

812. Was any portion of that intended as compensation, with a view of deepening the navigation?—Decidedly.

813. How much?—10,000*l.*

814. (Mr. *Hume.*) Were you a party to that estimate?—I was.

815. Do you consider, then, that if 10,000*l.* was paid by the Railway Company, the injury which the new line would do to the navigation might be compensated by that 10,000*l.* in establishing dredging vessels, and otherwise clearing the shoals?—That is precisely my opinion; at the same time it is proper to state that the agreement has been definitively entered into with the Company by the Commissioners, against the voice of a minority of those Commissioners accepting 16,500*l.*

816. Has any protest been entered in the minutes of the Quay Commissioners against taking the reduced sum, instead of requiring the amount which was originally demanded, including the improvement of the river?—There has not.

817. What was the division?—I cannot remember.

818. Was there a considerable number?—I think there was only a small minority.

819. (*Capt. Sir G. Bremer.*) Did the Railway Company refuse to pay the 25,000*l.*?—They did. I may state that the public meeting called in Lancaster had a considerable influence on the Commissioners of the Quay, in coming to the determination to agree with the Railway Company for the sum of 16,500*l.*, which would simply put them in the same position in which they were before the railway came. The opinion of the minority was very strong, that that was not sufficient compensation for the injury that would be done to the navigation.

820. (*Capt. Washington.*) Are there any sailors among the Harbour Commissioners at Lancaster?—Yes.

821. How many?—I think a majority are either connected with shipping or actually owners of vessels.

822. (Mr. *Godson.*) When you state that 10,000*l.* would compensate for putting the bridge across, I want to know whether you mean that the bridge would cause an injury requiring 10,000*l.* to repair that injury, so as to leave the river as it is. Do you mean that 10,000*l.* would enable you not only to remove any injury that arises from the bridge, but to do other improvements that ought to have been done long ago?—The Commissioners consider (those whose opinions, in this respect, I represent) that, as the Railway Company would save something like 25,000*l.* to 30,000*l.*, the port was entitled to the whole of that saving by the deviations of the line, provided the sum, whatever it was, that exceeded the amount of compensation was laid out in the improvement of the river. The Commission is dissolved, and a new one has been appointed. We were sent here to represent the views of the old Commission. I believe those views will be found to be considerably changed; that they will be found to be a body desirous of carrying out any improvement which may be suggested by the Admiralty or other persons in authority; and I believe they agree with me in the feeling that, if according to the bargain at present existing between the Commissioners and the Railway Company, namely, 16,500*l.* should be paid by the Railway Company; and a further condition insisted on, that

Mr. *Wm. Robinson* and Mr. *Edmund Sharpe.*

May 9, 1845.

the bridge should be raised to such a height as to permit access to the present quays by vessels of 100 tons burthen, that would be found to suit all the purposes of the town, and entirely to satisfy the Quay Commissioners, and the best for the interest of the port.

823. (Mr. *Hume.*) Without any money whatever towards deepening the river?—Certainly. I consider that the whole of the 16,500*l.*, if the bridge be so raised as to permit access to the present quays, would be available for the improvement of the harbour.

824. Can the bridge be so raised, consistently with the level of the railway?—I conceive there is no difficulty.

825. (Mr. *Godson.*) For how much money?—From 5,000*l.* to 10,000*l.* in addition to the present cost.

826. (Mr. *Hume.*) In case of raising the bridge to admit of communication with the existing quays, and render new quays unnecessary, what height will be required?—I beg to refer the Commission to Captain Denham.

827. If the height of the bridge should be raised to that point which you have intimated, do you consider that the 16,500*l.*, as agreed on, would then be sufficient to clear out the navigation of the Lune, and render it navigable for vessels of 16 feet, up to the bridge?—It exceeds by 3,000*l.* the amount of Mr. Stevenson's estimate for doing it.

828. Consequently, you would consider that to be a fair margin to carry on the works?—Precisely.

829. (Mr. *Godson.*) Supposing the Railway Company to keep to their old line, and do not contribute a penny, have you any fund by which you can deepen the river yourselves?—Yes.

830. What do they arise from?—We have a debt of 4,100*l.*, but we have the tolls, &c., upon which we can borrow, probably, 30,000*l.* The Railway Company that I have spoken of, before, coming to the port, are anxious for improvements of the port, and would no doubt be ready to assist us.

831. (*Chairman.*) What is your average annual income from toll?—I speak with uncertainty on that point, but it is about 1200*l.* a-year.

832. (*Captain Sir G. Bremer.*) What is the railway to which you have just alluded?—The North Western Railway, which comes direct from the West Riding to the sea at the port of Lancaster.

833. (Mr. *Hume.*) Through that do you expect a great increase of tonnage to pass?—Yes.

834. (Mr. *Godson.*) Are you connected with that railway?—I am.

835. What are you?—I am the secretary of that railway, which was projected mainly with a view to the improvement of the port of Lancaster.

[*The Witnesses withdrew.*]

Mr. *John Swift* and Mr. *J.E. Errington.*

Mr. *John Swift,* Solicitor to the Lancaster and Carlisle Railway Company,
and
Mr. *John Edward Errington,* Civil Engineer,
} sworn and examined.

[Major *Maclean,* Chairman of the Lancaster and Carlisle Railway, and *Henry Howard,* Esq., of Greystoke Castle, in Cumberland, were present.]

836. (*Chairman.*) (To Mr. *Swift.*) You are aware of all the circumstances connected with the proposed deviations from the original line of the railway?—I am.

837. The Commission is apprehensive that that new line will produce considerable impediment and injury to the navigation of the Lune?—That is, perhaps, very much an engineering question, upon which I may not be so well qualified to speak as others; but we were led to a contrary conclusion by an application from the town of Lancaster by a memorial which I hold in my hand, and in which the great advantage to Lancaster is represented very strongly, and the great disadvantage of constructing the line in the direction in which it was at first authorized.

838. The proposition came from the town of Lancaster to the Railway Company?—Certainly.

839. Then was there a proposition made from the town of Lancaster to the Railway Commissioners for compensation, by which they might be enabled to build new wharfs and also to deepen the channel?—Yes, that followed from the Quay Commissioners. The application was from the town to us, and that brought us into communication with the Quay Commissioners, and the Corporation and the Quay Commissioners asked for a sum of money; consequently an agreement was concluded for a sum of 16,500*l.*, a portion of which money was to be applied, as was stated to us, to the improvement of the river, and another portion to the restoring of wharfs below the new intended bridge, and to the compensation becoming due in that event to parties having property above the bridge. I should state that that memorial is signed, among other persons, by nine of the Quay Commissioners.

840. What date does that memorial bear?—Lancaster, 26th of June, 1844.

841. Signed by nine out of how many Commissioners?—Out of 16.

842. (*Captain Washington.*) You speak of the former Quay Commissioners?—Yes.

843. (*Chairman.*) The Quay Commissioners are elected triennially?—I believe they are. I hold in my hand a list of the names of the persons. I have no personal knowledge of their office as Commissioners; but this was given to us as containing a list of nine gentlemen who were Commissioners.

844. Did they sign it?—Yes, and a separate paper was given showing they were Commissioners. I should state that at the public meeting which was held before the agreement was concluded, which was largely attended, and a report of the proceedings of which I hold in my hand, many gentlemen attended also from Lancaster, and among others Mr. Greene, the member for the place, and he appears to have taken a part in the discussion in favour very

much of the new line; and the letter appears to have been read at the meeting from Mr. Marton, the other member for the town, also approving of it.

845. (Mr. *Hume.*) In this memorial it is stated that the navigation will be improved by the new line. Was there any discussion, or has there been any specification in what way the navigation will be improved by the bridge being brought below the town, instead of above the town?—I think not. It was spoken of at that meeting, as for the promoting, carrying on, and effecting a design so beneficial for the town of Lancaster, and so conducive to the increase of trade and navigation and the good of the public. That is signed by Robert Greene Bradley, E. D. Salisbury, Thomas H. Higgins, John Lodge, William Jackson.

846. You have stated that the money to be possessed was to be employed in improving the navigation?—Partially.

847. What portion of the money to be so employed?—We never inquired.

848. Was any greater sum than 16,000*l.* required?—Originally more was asked.

849. Was any written application made to you, and did it state for what purpose the larger sum was wanted?—I have no recollection of a written application; verbal communications were made, but to none of which, to my knowledge, was any particular apportionment of the money mentioned.

850. What was the amount originally demanded?—I think 20,000*l.*; we were thinking of about half that sum, and ultimately we were induced to get up to 16,500*l.*

851. Were you, the Railway Company, willing to appropriate any portion, and what portion of that towards the improvement of the navigation?—I should not be dealing candidly if I affected to say we thought much about it; we considered it was a sum of money to be paid to the Commissioners, they stating that they meant to apply a portion of it to the improvement of the river, but we did not inquire what portion.

852. Is it not usual, on demanding compensation, to state for what objects that compensation is required, and as you have mentioned that it was for the improvement of the navigation, can you not state what portion of that compensation was demanded for that purpose?—I cannot.

853. If the Commission are satisfied that the navigation would be impeded by the erection of a bridge lower down in the new situation, is the Railway Company prepared to make any compensation to enable the navigation to be compensated by deepening, or otherwise for any injury received from your bridge?—We consider we have paid largely and liberally in the sum named.

854. If it shall appear that that sum which you agreed to give will scarcely be sufficient to compensate for those purposes, will you be prepared to afford any larger sum to deepen and improve the navigation?—We have never considered that question. Without consulting the directors I should not be prepared to give an answer, except that we consider we have already paid a very large sum.

855. Would there be any and what objection to raise the bridge, which is now 32 feet, to twice that?—That was discussed much with the Commissioners at the time. It was matter of great consideration and repeated interviews and discussions. I think the lower height was first agreed to, and we afterwards agreed to raise it to 32 feet, which was stated to be quite sufficient.

856. Was not that height considered sufficient when the proposition came of building quays below the bridge instead of using the quays above the bridge?—Certainly; but I fancy a height of 80 feet is impracticable, or any height greater than our present height.

857. (Mr. *Hume.*) (To Mr. *Errington.*) What is the objection to raise the bridge where it is to cross the Lune so high as to enable the vessels that now use the quays above that space to continue to use it?—I have no hesitation in saying we should never have entertained the project; that we should never have attempted to change our line, if we had contemplated such an expense as that would involve; from the position of the ground, and various other circumstances, it would be an enormous expense. I cannot state at this moment how much, but it would be all but impracticable as connected with our project, and the position in which our bridge was formerly placed.

858. (*Chairman.*) In the event of your being obliged to raise the bridge to the height of 70 feet instead of 32, I understand you would give up your new line altogether and prefer the old one?—Most assuredly; it is my opinion.

859. (Mr. *Hume.*) What amount of compensation would the railway be willing to give. leaving their other arrangements to be such as they please towards the improvement of the river; the deepening of the river from the bridge downwards to compensate for the impediment the bridge may give?—(Mr. *Swift.*) The fairest way to answer that is, supposing we had not been asked by the Quay Commissioners to give any specific sum to them, we should have been willing to pay the parties whom we were damaging, warehouses, for instance; and then to have considered what is the proper sum to contribute towards the improvement of the river.

860. What would that amount be?—The only sum ever spoken of to us was 2000*l.* or 3000*l.* for dredging the river, and something of that sort.

861. (Mr. *Godson.*) Supposing the agreement between you and the Quay Commissioners were set aside altogether, and that you had now to form a new agreement, that is, to compensate the people whose lands you had taken, how much would you then be prepared to give for putting down the two piers in the river?—That perhaps is matter for the Directors to consider, but I should have thought if they had been asked to give 2000*l.* or 3000*l.*, or 2500*l.* (we were never asked any sum), we should probably have been disposed to do that.

862. Supposing that agreement were set aside altogether are we then to understand that you estimate the damage you are doing to the river, by means of the two piers you put in, at 2500*l.*?—Yes, we have never thought of any other sum than that.

[*The Witnesses withdrew.*]

Adjourned till Wednesday, the 21st instant, at 10 o'clock.

Wednesday, 21st May, 1845.

Present:—

Captain Sir GORDON BREMER, K.C.B., in the Chair.

Mr. Hume, M.P.	Captain Beaufort, R.N.
Mr. Chapman, M.P.	Mr. Godson, M.P.
Mr. Airy, Astron. Royal.	Captain Washington, R.N.

Capt. H.M. Denham R.N., F.R.S. — May 21, 1845.

Captain H. M. Denham, R.N., F.R.S. examined.

863. (*Chairman.*) You are a Commander in the Royal Navy?—Yes.

864. How long have you been engaged in the surveying service?—Thirty years.

865. Will you state the parts of the coast of the United Kingdom that you have surveyed?—I assisted to survey the Channel Islands (Guernsey, Jersey, Alderney, &c.) I acted as chief assistant in the surveys of the English and St. George's Channels, from the straits of Dover to the edge of soundings; the coast of Ireland, from the Shannon to Belfast, including Beerhaven, Crookhaven, Valentia, Baltimore, Glandore, Cove of Cork (entrance), Youghall, Waterford, Carlingford, Strangford, Ardglass, Belfast, Copeland Isles, Larne; on the English coast, Falmouth (sound), Helford, Manacles (reef), St. Helen's Pool, Scilly Isles, Skerries, Start Bay, Salcombe, Plymouth Sound, Dartmouth. I have conducted the surveys of the Bristol Channels throughout, including Hartland Quay, Cloodly, Barnstaple Bar, Appledore, Ilfracombe, Minehead, Watchet, Bridgewater, Kingroad off the Avon, Cardiff, Newport, Chipston, Swansea, The Mumbles, Llanelly, Estuary of Bury, Carmarthen, Tenby, Milford Haven, Solvach, St. Bride's Bay, and Lundy Island; coasts of Lancashire and Cumberland, with the Dee (to Chester), Liverpool Bay, and Mersey; Morecambe Bay, including Fleetwood, Lancaster and Piel a foudra; The Duddon and Ravenglass Estuaries, Whitehaven, Workington, Harrington, Maryport, and Douglas, Isle of Man.

866. In your survey of the River Lune and Morecambe Bay, did you examine the river and bay with a view to the improvement of the port of Lancaster?—Not with that view, but to the general development of the bay.

867. Have you formed an opinion upon the subject?—Yes.

868. Will you state your opinion?—Taking the Lune in its present outfall, we trace it down a sea-reach, through sands of four miles depth, obliquely to the flood and ebb-tide sets. As soon as I found what really was the shallowness and tortuosity of that sea-reach channel, it struck me as a hopeless case the maintaining the exit of the River Lune in any course that it had hitherto taken to itself. While such was developing itself, I found (where the region was considered as blocked up by sands) a hitherto undefined retention of tidal water or arm of the Irish sea with very slight interruptions, none of them, with one trifling exception (Low Scare), rising nearer the surface at low water than 18 feet, reserving 20 to 30 feet depth at the Old Scare, called Poulton Ring, on the northern side of Heysham promontory. Since then my attention has been called to the possibility of reviving the trade of Lancaster, a project I have scrutinized, and there certainly is a capacity of water available at all hours of the tide with pretty nearly a straight course from Lune Deep.

869. In order to establish a harbour at Poulton Ring, you must cut a sea passage nearly north to communicate with Lancaster?—That is only supposing a water-borne transit in connexion with Lancaster desirable, but it does not follow that any of the river water is required to create or maintain such a port there. Railway connection might reasonably suffice, and it should be well weighed whether the diversion of the river water might not be mischievous in the formation of such harbour.

870. (Mr. *Hume.*) Do you propose to cut a new harbour at Poulton, and to carry that up to join the Lune at Lancaster, or do you intend to use the railroad?—All the purposes of a harbour, and ready tidal connection with Lancaster could be effected without interfering with the Lune at all.

871. What is the distance?—Two miles and three-quarters.

872. Will that bring you to Lancaster itself?—Not to Lancaster itself, but opposite the warehouses on the north side of the river, where the Carlisle railroad crosses the estuary.

873. You mean the one that is to cross below Lancaster?—Yes, a canal might be borrowed from the river for the purpose of transporting ships to the basins, which might be created upon the northern side of the present river. Whilst the transit of passengers and light goods by packets and coasters would take place by railroad in the easiest possible way, being so short a distance. For the purpose of passing ships nearer to the Lancaster warehouses, and putting them in any future basin on the north side of the river, the canal connection for ships might be desirable, and easily arranged. Turning the Lune altogether I do not see the desirability of, perhaps better that it should not, for the sake of the harbour that is to be formed, when we recollect the silt which it is charged with. The only inducement to turn the Lune would be the saving of all the land that the estuary now presents at low water. For the purpose of the new harbour, I would say that the desired breast-works being built on the Old Scare, there would be no assistance required, except a canal communication to feed a lock-basin, and transfer cargo by flats; and if found more desirable, to transport a ship with her cargo nearer the town than to unship it and pass it on by the railroad.

874. Do you consider the latter course for trade preferable to any endeavour to improve the navigation of the Lune as it now is?—Certainly.

875. Have you examined the different parts of the Lune, descending from Lancaster to Glasson?—Minutely.

876. Is it in your opinion capable of being deepened so as to admit vessels drawing 16 feet water up to where the new bridge is to be?—Certainly, anywhere between Glasson dock or Sunderland Point and the new bridge or viaduct. It is quite within engineering practice of being deepened and straightened.

877. Have you formed any opinion as to the expense which would be incurred in removing the impediments, so as to deepen it to the extent stated?—I have not. It would be not merely deepening, but the greater part of the expense would be in forming directing walls and embankments to preserve it.

878. Have you formed any estimate of the expense of the connexion by canal from Poulton-le-Sands, southward, up to Lancaster?—I have a conjecture like 130,000*l.* to create the breast-works, basins, and canal connexion.

879. What would be the expense supposing no canal were formed, but the quays were made at Poulton and the conveyance left to the railroad?—About 100,000*l.* The greater part of the 130,000*l.* would be in constructing the breast-works, piers, which would be nearly half a mile in extent to embrace the whole rise of tide and the excavation necessary to form a tidal basin.

880. Do you mean a basin for vessels to lie in?—Yes.

881. In what depth of water then would vessels enter at Poulton?—Where the pier-head would be projected, a few yards only beyond the present low water mark, there would be 12 feet of water without any deepening. The excavation within would have to be wrought to a depth of 14 feet to attain a layer at low water level, but no deeper, on the eastern aspect of the breast works, an enclosed float should be formed with lock-gates, to avert the possibility of a mere tidal basin filling up again; vessels arriving at half-flood would lock into such basin and docks.

882. (*Chairman.*) With regard to the facilities of navigation are you of opinion if there was a harbour at Poulton and ready access from the sea, ships would be enabled to get up there, and the vessels might be discharged, avoiding the delays and sinuosities of the river Lune?—Yes. I may remark that I have known ships drawing 16 to 18 feet water, bound to Glasson dock, detained five and six days, waiting for the spring tides to lift them over the four-mile sea-reach and bar.

883. (*Capt. Beaufort.*) The whole of that opinion is formed upon the supposition that that harbour will remain?—Yes.

884. Have you compared your survey with the ancient charts, and found no great change has taken place in the extent of those sands?—The only reputed survey that I have heard of I caught a glimpse of to-day. I have not yet compared it side by side with my survey of 1844 now on the table, but I would say that, considering that survey was projected in the year 1826, only 19 years ago, it could not have represented the features of the banks at all at that time from the immense difference that appears.

885. From the reports of people on the spot have those sands advanced or not?—They have not. There has been a change of the Kent from what I now call the False Grange Channel. The Kent diverged to the southward in the year 1838, breaking through into what is now called the New Grange Channel, presenting the Victoria opening.

886. (Mr. *Hume.*) How high does the tide flow up the Kent river?—Within half a mile of Levens Bridge, beyond Milnthorpe.

887. How many miles is that from Poulton?—Twelve miles.

888. Is it navigable to that extent?—An occasional flat gropes up to Milnthorpe, *i. e.* Sand-side beach.

889. (*Capt. Beaufort.*) Is it intended to run an embankmant across those sands?—I have heard so much of that that I have been careful to anticipate the queries that would arise in case such a matter came before Government, a question or proposition that may occur at any time. There is a great desire to inclose this bay, with the permission of Government, both to create a vast agricultural accession to the county, as well as for railroad communication between Lancashire and Cumberland.

890. If such a thing should ever be carried out, would it not altogether and entirely destroy the projected harbour at Poulton?—Perfectly; they are not compatible except by the Kent and Keer rivers being brought down that side of the bay and maintaining the harbour channel for a time.

891. What would be the effect of the second projected line?—Equally inimical.

892. (Mr. *Hume.*) Explain in what way that enclosure of the sand would affect and destroy the harbour?—I consider the present depth of water that is retained abreast of Poulton Ring, in connexion with Lune Deep, to depend entirely on the reflux of the vast body of tidal water taking place, as well as the pressure of that influx now required to fill the bay area.

893. What is the depth of water over those sands at high water springs?—Over the crown of Cartmell Wharf nine feet; following the section across on the western edge it is 13 feet; three miles further on it is nine feet; we then come to 13 feet below low water level in the channel; three miles further we come to 17 feet depth below high water level.

894. (Mr. *Hume.*) Have you made any calculation of the amount of tidal water to be excluded if the project was carried out?—57,000 acres.

895. Are the Board to understand that any inclosure of any portion of these sands would tend to lessen the depth of water in the bay?—Yes; the several deep pools, channels, and dykes, which are considered to be caused by the out-fall and dip and scour, would be choked in proportion.

Capt. H.M. Denham, R.N., F.R.S.

May 21, 1845.

896. Is it your opinion that no inclosure of sand over the tidal water flow should be permitted with a view to preserving such channels as do exist?—As far as relates to the channel in connexion with the outer or broad waters, for I conceive that *they* depend on the quantity of tidal water that flows and returns; but inside I would embank all bights and sinuosities, and straighten the river course to render permanent the depths and channels once obtained, the which never can be attained or maintained while the water is allowed to go over it as a broad sheet expanding over a chance-shapened estuary, where the sands are diurnally buffeted about. I find that the river waters cannot course down permanent channels; whilst the tidal flow upsets whatever the river would do of itself if confined.

897. You consider that the reflux of the tide ought to be confined within such limits as would direct its velocity, and deepen its channel?—It would give the river the full advantage of preserving a water-course down, but when I come outside I consider so far as regards the maintenance of such gutter-ways which appear upon the plan, a great deal depends on how far that is charged with tidal water as well as the fresh. There is a distinction that occurs to me in that respect. I would wish to add, that where an eddy is formed in any portion of the river I would endeavour to cut off the cause of that eddy.

898. (Mr. *Airy*.) Could you rely on the permanency of a harbour at Poulton?—Giving the term a century to range over, I should say there is every chance of maintaining it. There has been from time immemorial navigable water off Poulton Ring; cruisers that were looking out for smugglers or to press men last war, took up anchorage there; but so little understood that it has never presented the refuge it might within the limits of the bay. There is not a buoy or beacon, or light to lead to it.

899. (*Chairman*.) How far back is your own knowledge of the nature of the anchorage off Poulton?—My local knowledge is confined to the past year, that I have been surveying that particular part.

900. (Mr. *Airy*.) What is the section of the land between Poulton Harbour and Lancaster?—In an engineering point of view it may be called a level, and very little above high water level.

901. (Mr. *Hume*.) From the attention you have given to the navigation up to Lancaster, if you had 10,000*l*. to expend, in what way would you expend that sum to do the greatest good to the navigation?—I should attempt to do nothing with such a sum, beyond lighting and buoying, and perching the present channels and shallows, that is as they now exist, the buoys, &c. being subservient to the changes which are constantly taking place.

902. (*Capt. Washington*.) Are you aware that an estimate has been made by the engineer, Mr. D. Stevenson, that 7000*l*. would be sufficient to enable the Lancaster people to have 16 feet water all the way up?—I was not aware of that, it is worthy of weight though, but certainly not my opinion.

903. (*Capt. Beaufort*.) What lights would you require?—I consider so much of the real access of the Lancaster navigation to depend upon such a point as Fisher Bank Patches, which dry at low water, extending three miles on a six-feet ridge, and covering a space of three miles by two, with not less than five and six fathom water at low water, so important as a breakwater. The knowledge of it, and the clearing of its spit would depend so much on being lighted, that I would put a floating light on the south-west spit of those Fisher Bank Patches. Then I would have tidal lights put on Sunderland and Chapel Points, or Abbey Scare.

904. Do you think vessels could go up there at night?—They now cannot possibly do so at high water, but they would then be enabled to obtain a position in Sunderland Hole, or proceed to Glasson Dock.

905. Before the channel was straightened as you suggested?—Yes, as the straightening process is only practicable above (within) Sunderland Hole.

906. (*Capt. Washington*.) Are the Commission to understand that if the passage were sufficiently lighted and buoyed, ships could run three or four miles up into a place of safety, which they cannot do now?—Yes, over the present four miles of bar (flats).

907. (Mr. *Hume*.) Are the arrangements for lights local or public?—Local. The St. George's Quay Company of Lancaster are the proprietors of the only light that pays general toll, which is called Walney Lighthouse. That light is imperfect in its action. Three or four buoys are placed in an irregular way, sometimes on one side of the channel, and sometimes on the other, and I should say if they ever have 10,000*l*. to lay out, the first expenditure should be in establishing elements to render that which exists more available than it is.

908. Under whose jurisdiction are those buoys?—The Quay Commissioners of Lancaster.

909. Who do they employ?—A buoy-master.

910. (*Capt. Washington*.) Do you consider the Quay Commissioners competent to look after buoying and lighting the channel leading up to the town of Lancaster, and for the coast trade?—I have no doubt of the efficiency of them in their trust and position, but I think that beyond the *high water* mouth of their own river, *local* trustees should have no control over the navigation in *any* case.

911. (Mr. *Hume*.) Then is it your opinion that the lighting and buoying of all parts beyond the high water mark should depend on the Trinity House, or some other public Board, and not on the Local Commissioners?—Certainly; my experience leads to that conclusion.

912. By whom was that lighthouse on Walney Island erected?—It was erected in 1789, under an Act of Parliament by the St. George's Quay Commissioners of Lancaster.

913. (*Capt. Washington*.) Is it a harbour light?—A channel and bay light.

914. (Mr. *Hume*.) Do you consider from the situation of that light on Walney Island, it ought to be considered a harbour light, or one of the general lights for the channel?—A general light for the channel, and every vessel coasting from Liverpool to the Solway depends on it. Every vessel coming into the bay pays, whether bound to Lancaster or not.

915. What do you consider the limits of Morecambe Bay?—From Walney Point to Rossal Point.

916. Do vessels passing outside that point pay?—I understand so.

917. (*Chairman.*) You consider the light to be necessary and useful on Walney Island?—I consider it a most important light.

918. What is the nature of the Walney light?—A tower, 80 feet high, with three Argand lamps and reflectors revolving, obscured every five minutes, showing bright but one minute.

919. (Mr. *Airy.*) Are you able to state whether the navigation of the River Lune during the last 20 years has improved or deteriorated?—Deteriorated.

920. Are you able to point out in what manner, or from what reason that deterioration has taken place?—The connection between the mouth of the Lune at the high water orifice and the low water summit of tidal level has extended and silted so as to present a bar of 4 miles extent, and has dammed up a great deal of the out-fall of the scour, and instead of the last of the scour escaping to sea, or Lune Deep, as it used to do, it merely sweeps over the banks, which arrests its silt, that would otherwise have been carried out.

921. (Mr. *Hume.*) Would the employing of a dredging machine at the spot, to which you have alluded, tend to restore the river and improve the depth?—I should say that no dredging power would have any effect.

922. (*Capt. Beaufort.*) Did you not find very great benefit arise, and a very much cheaper system, in raking the entrance into Victoria Channel, at Liverpool?—Yes, by a system of harrowing.

923. Might not the same system be employed here with great benefit?—I think not, when comparing the two cases; the difference being in reference to the filling and discharge of that estuary down the long and wide Crosby Channel, and where I found that set impinging I harrowed to encourage it, and we got it over a mile of bar, which was impelled by the twenty miles of outfall. In the Lune, however, we have the four mile bar with a power of back water, which I consider quite inadequate to help permanently; besides the flood sets obliquely over the Sunderland shoulder and Cockerham sands. Whatever friction is effected then in the course of the two or three hours of ebb tide, is filled up by the cross set during the other nine hours.

924. You have an oblique traverse of tide?—Yes.

925. When the sands rise above the water and the water subsides into the channel, would you not then carry out what was retained, as well as out of the channel?—Yes, the last two hours of the ebb would scour.

926. (*Chairman.*) Explain the time that the sands are dry?—The upper part of Sunderland Shoulder, at a mile from the shore, are dried at one hour's ebb; at two miles two hours' ebb; at three miles dry at half ebb; and so on to the spit at low water.

927. (*Capt. Beaufort.*) If you were to begin at the outer part of the bar, and for the two last hours of every ebb rake up and disturb the bottom, would not two hours carry out the stuff to sea?—Undoubtedly it would; yet the nature of the sands right and left is such that I think it would fill up every space in the course of the succeeding tide.

928. (Mr. *Airy.*) Your opinion is, that the cause of the great injury of Lancaster navigation is the general extension of the sand?—Yes.

929. (Mr. *Hume.*) What is the rise and fall of the tide at the foot of Lune?—28 feet.

930. What is the height at Glasson?—24 feet upon equinoctial spring tide, 21 feet ordinary spring tides, and 12 feet at neap tides.

931. Do you know how high it rises at Lancaster?—At Lancaster Bridge we have 11 feet at high water ordinary springs.

932. What will be the depth of water between the present bridge and the intended viaduct?—14 to 17 feet at high water ordinary springs.

933. (Mr. *Chapman.*) What is it at low water?—6 and 7 feet water. With respect to the Lune I would add that the estuary is, like its sea reach, a maze of variable sands, without a light or any system of buoyage. The very sea-reach itself has but four black buoys to mark its four miles of vague course, and a perch to distinguish the Abbey Scare, which lies on the southern hand, abreast of which, and for three quarters of a mile above lies a 10 feet and 12 feet pool, called "Sunderland Hole," the best part of which, half a cable wide, is abreast and northward of the second perch. It would be impossible to offer any defined sailing directions where such a paucity of elements exist; no man can have any business above the first buoy at the foot of Lune, which is 11 miles below Lancaster Quay and 5 below Glasson Dock, without a pilot's knowledge, and there and then wait high water, or indeed a spring tide lift, if a voyager.

934. (Mr. *Hume.*) Did you make any representation to those Commissioners who have the charge of that navigation, as to the want of such buoys as you have now pointed out?—No, I considered it would be informal whilst preparing an Admiralty survey.

935. If the course of that estuary, and other estuaries which you have visited were placed under proper independent authority, do you consider that such navigations might long ago have been benefited?—Yes, I know to the disadvantage of such navigation, that persons undertaking to manage intricate seaward channels, is, that the chief of their trouble is with the toll-receivers, who are so reluctant to pay for the outer improvement. His constant fever is in vain endeavours to impress them, and relieve the exigency from the trammels of false economy; instead of a Board who would look only and promptly to the merits of his propositions, and decide on the outlay.

936. Then are the Board to understand that you think some competent authority ought to exist on the part of Government, to compel the proper application of any dues that might be raised with a view of supporting local harbours?—Certainly; it is the one thing needful.

Capt. H. M. Denham, R.N., F.R.S.

May 21, 1845.

937. Have you observed the same neglect of improvement in navigation in other estuaries under other local authorities?—I have, particularly where the difficulties and anxieties lay seaward of the mouth of the river.

938. You are understood to say that wherever the approaches to an estuary extend beyond the land, it ought to be under a competent authority to direct an adequate number of buoys and other improvements that are requisite?—Yes.

939. In that case do you consider that the capabilities of the different harbours you have seen might be much improved?—I do.

940. Then is it your opinion that there should be an authority, like the Admiralty for example, with proper officers to superintend the coast of this kingdom, to see that the harbours were kept in the best possible order, instead of being left to the administration of interested and local bodies?—I do think it necessary.

941. (*Chairman.*) Do you consider that the inattention which you state has been shown with regard to this sea-reach, proceeds from a want of knowledge, or from a disinclination to appropriate certain funds?—I take it that the servants or persons employed to look after these things are held so completely from hand to mouth in their position, that they are afraid to press, and they do not get supported by the local authorities.

942. Do you think they have not the knowledge?—Local trustees rarely have enough knowledge, though the buoys may be entrusted to competent persons.

943. (Mr. *Airy.*) The great scour of the Victoria Channel, Liverpool, was undertaken by you?—It was.

944. Did you find any difficulty in carrying that measure?—So great and vexatious a difficulty, that the moment I had done it, I resigned the appointment of 700*l.* per annum.

945. (*Captain Beaufort.*) With respect to the Lune. Could no cheaper mode of directing the tide in its proper channel than the walls you spoke of be adopted?—I think not, where the tide rises 17 or 18 feet. The cheaper system of conducting water by weirs and cheverons could not apply.

946. (Mr. *Airy.*) Do you think a dredge would maintain itself?—No. My idea is, that the upper surface of every embankment should come above high water level three or four feet, if the approaches to these banks are under water at any time, they present, upon the slightest deviation of steerage in thick weather, under water ledges, on which vessels would hang and bilge.

947. (*Capt. Washington.*) Are you aware that the greater part of the embankments of the Clyde are half and quarter tide embankments?—Yes, but I have only considered them as being the foundations of progressive building.

948. On the contrary, the engineer recommends that all those be pulled down and half embankments marked out?—Then it must confine the stream to steam navigation, which can at most times command the course.

949. Will not dykes coming above high water, exclude the tidal waters which you have yourself stated it is a very great object to preserve in their full power?—In my opinion no part of the tidal water that goes into the Clyde would be of any use to the Clyde itself, but that as there are banks outside the high-water orifice off Greenock, there may be some jealousy about cutting off the tidal water that used to go up the Clyde, and those bars increasing for want of former back-water, and that is my first position, viz., that banks outside the high-water orifice require all the tidal water to help the scour, but I think it better for the sake of the part within, that dykes and embankments be brought above high-water level.

950. (Mr. *Hume.*) Have you not yourself stated an opinion that the last half of the tide-scour is important to keep the channel deep?—Yes.

951. Have you not stated also the advantage of allowing as great a flow of the tide upwards as possible?—For the sake of the outer bars.

952. Would not, therefore, half-tide dykes, while they permitted the full flow of water up, also direct the scour in the latter half of the ebb to the proper channel?—No; I do not perceive that the water thus descending would have any effect in keeping any particular course clear in that estuary.

953. Would there not, with a large quantity of water poured out by the ebb, be a better chance of carrying off the silt than if the quantity was limited, as you have stated, by walls? No, I think not, as respects the *interior* part of the estuary.

954. (*Capt. Washington.*) What would you recommend, under present circumstances, for the improvement of the port of Lancaster?—I would recommend abandoning the Lune to its present course, *in toto*, and making available the arm of tidal water that now exists up to the Poulton Ring, which will bring a ship or packet at *low water* spring tide within three miles of the town, instead of leaving her at an anchor for hours, and sometimes days, 11 miles from the town.

955. You mean by establishing a harbour at Poulton?—Yes.

956. Looking at the possibility of an embankment being run across Morecambe Bay, which would entirely destroy the projected harbour at Poulton, what would you recommend, under all the circumstances of the case, for the improvement of the port of Lancaster?—I would recommend that the present sea-reach over Sunderland and Cockram sands be assisted by more buoys, while all the interior part of the estuary should be straightened as much as possible by embankments for the defined outfall of the river Lune.

957. (*Capt. Beaufort.*)—Has any plan, to your knowledge, been made for the various lines that you have marked on your chart for embanking Morecambe Bay?—For the line A, D, on the plan—that is, from Poulton-le-Sands to Point Comfort—it has been considered and discussed in the Report of the Commissioners on Packet Communication with Ireland and Scotland.

Capt. H. M. Denham, R.N., F.R.S.
May 21, 1845.

958. Do you consider it a feasible plan?—Yes.

959. What would be the general advantages of it in point of navigation?—I think the general advantage would be stopping the indraught to half its present extent into the bay, which at present exists and has been so fatal to the mariner.

960. Do you not consider such would be mischievous?—No. I think with reference to Ulverstone navigation up the Leven, that it has so languished from other causes that it is quite within the scope of the most reasonable compensation, and that the Kent navigation has also so diminished, that if it was not for the possibility of a harbour being formed at Poulton Ring to restore to Lancaster its shipping importance, then even the Lune and all below might admit that embankment for the sake of redeeming such a vast tract of land. The original idea was that it should be so constructed as to carry a railroad to connect the West Cumberland Railway, which, for want of it, is now diverging round over the Leven and Kent to connect Lancaster and Cumberland.

961. (Mr. *Hume.*) What would be the depth of water at that embankment at high water?—Varying between 41 and 9 feet.

962. *Capt. Beaufort.*) At what average depth would the piles or other means you would adopt to make the embankment come to solid ground?—Nine or ten feet below the present surface.

963. Have you considered the causes that led to that singular phenomenon, the Lune Deep, which in one part suddenly jumps from 3 feet to 154 feet?—I have reason to believe that the mouth of this bay, which is eight miles from point to point, was not more originally than a mile and half in width. I find on either side of that original matter, not deposit, but such as must have been *terra firma*, where buildings and roots of trees are traced, and that Lune Deep was the channel into which the Lune poured, with all the other rivers, and that it is now filling up in proportion as the mouth of the bay has been widened; that all the subsoil has yielded gradually to the friction of the tide, and that its present existence is in a great measure ceasing, but it would fill up much sooner if the vast quantity of tidal water that rolls into the bay was intercepted. I do not consider the Lune Deep as it is traced and gauged in that remarkable dyke to be at all the result of tidal friction in the beginning, but that it is an original formation.

964. What reason have you to think that the Lune Deep is now filling up?—From the submarine tongues and spits which point at it from all the banks that are known to be increasing within it; for instance, Clarke's wharf; and I perceive, corresponding with that, a shelf is coming down gradually into the deep, and I have learned that the inner extreme of the deepest part of the deep is below the foot of Wyre water, whereas it used to be above it.

965. How much has it changed?—It is spoken of as having been up as far as the Lune buoy, say one mile.

966. What sort of embankment could be built from Poulton to the other side which would resist the action of the sea?—Proceeding on a piling frame, and depositing rubble stone, completing ledges of four feet high, returning and going on in layers of that sort with a proper bevel seaward, and that as these layers went on the tidal water would, from the time it rose just above the level till it came up to half-tide level, entrap the silt, and thereby add to and level the back deposit, presenting an amalgamation of silt, cement, and rubble stone, guided by and tied by the pile-framing, would faithfully resist the sea, no longer hurried on by an impetuous tidal indraught; no difficulty, in fact, in creating such an embankment as would be safe, and available for land enclosure, with sluice-gates for the freshes, and carrying a railway.

967. If that embankment was made, would not the tendency be to destroy the entrance of the Lune with all the harbours in the whole of Morecambe Bay?—I would certainly say that the three existing harbours or inlets, Lune, Wyre, or Piel, would not be interfered with.

[*The Witness withdrew.*]

Mr. *John Macdonald*, Secretary to Arbroath Harbour Trust,
Mr. *James Leslie*, of Dundee, Civil Engineer,
} Sworn and examined.

Mr. *J. Macdonald* and Mr. *James Leslie.*

[The Provost of Arbroath and Mr. Lindsay Carnegie were present.]

969. (*Chairman.*) (To Mr. *Macdonald.*) What is your situation?—Secretary to the Arbroath Harbour Trustees.

970. How long have you filled that situation?—Since 1839, when the Act was obtained constituting the Harbour Trust.

971. Was that an Act for the purpose of creating the harbour of Arbroath?—It was "an Act for extending, improving, regulating, and managing the harbour."

972. (Mr. *Hume.*) (To Mr. *Leslie.*) Since that Act passed what works have been erected, and what money has been expended on those works?—The old inner harbour was the only harbour then existing, and all the works outside have been constructed. The sea wall, quay walls, and the breakwater, set forth in the plan, have been erected in pursuance of the Act.

973. Do you mean that the large inner harbour has been entirely formed, and the breakwaters?—Yes.

974. How have these works been finished?—By contract.

975. (To Mr. *Macdonald.*) What has been the amount expended?—The amount expended in the works altogether, including the compensation to the town for the old harbour, is about 58,000*l.*

976. Have you power to borrow any more money?—No; the power we got to borrow was

Mr. *J. Macdonald* and Mr. *James Leslie.*

May 21, 1841.

to an amount not exceeding 50,000*l.* We saved some money before the expenditure on the new works; we have exceeded our funds considerably, and we owe from 3,000*l.* to 4,000*l.* now, for which there is no present means of payment.

977. What depth of water has been obtained?—As yet no additional depth has been obtained. At present the depth of water is at ordinary spring tides from 11 to 12 feet only at high water.

978. In neap tides is the harbour dry?—In neap tides, when it is high water, it is 7 or 8 feet deep, and always at low water it is dry.

979. What further works are required to be done to make the harbour capable of admitting shipping, which the trade of the port can employ?—The estimate of Mr. Leslie is for an increased depth of 3 feet. The original plan was that it should be deepened from 5 to 6 feet; but if we had 3 feet additional depth of water it would answer the present purposes of the port.

980. (To Mr. *Leslie.*) To what extent does the proposed deepening extend from the outer heads?—233 yards.

981. (*Chairman.*) What depth of water do you get at the termination?—We propose to deepen down to low water of spring tides, and that will give about 17 feet at high water spring tides at the outside of the rock.

982. (Mr. *Hume.*) Is it dry at low water now to the extent you have stated?—Yes, of spring tides.

983. Have you to remove shingle or stone?—Boulder stones and soft freestone rock.

984. Has any estimate been made of the expense to be incurred?—Yes, and the amount is 9,000*l.*

985. Is there any party willing to contract to finish it for that amount?—We have not yet offered a contract, but my opinion is there would be no difficulty in obtaining contractors to do it. I think the prices I have allowed are quite ample.

986. What portion of that amount would be required to deepen between the old breakwater outward to the low water mark?—For the first 100 yards outward to the opening is 623*l.*; from the outer heads to the low water mark is 5,733*l.*, besides 10 per cent. for contingencies.

987. To what depth do you propose to excavate at the outer mouth?—The whole of it about three feet, just to take the present slope there is in it.

988. What vessel would it admit if finished to that extent?—Vessels drawing 16 feet of water at high water.

989. (To Mr. *Macdonald.*) Have you any funds by which you can make this excavation?—No.

990. What is the amount of interest payable on the money you have now borrowed?—About 2350*l.* a-year.

991. What other charges are there in maintaining the harbour?—About 700*l.*, or 800*l.* a-year, including the expense of management.

992. That, with the 2350*l.*, makes the annual expenditure 3150*l.*?—Yes.

993. The shore dues are put down in 1843 at 3050*l.*, what were they in 1844?—They have averaged that amount during five years.

994. Is there any probability of their increasing if the harbour is not deepened?—I think not.

995. Is there any probability of their continuing at that rate?—The harbour requires occasional dredging inside. The shore dues at present do not afford funds for this purpose, and unless they were increased by the harbour being deepened, so as to admit a larger class of vessels, I do not think that sufficient funds will be obtained in this way. I think if the harbour and the entrance to it are not deepened it will in time become comparatively useless. Freights for vessels coming to Arbroath with coal, I understand, have been charged 1*l.* a keel more than they would have been to Dundee under similar circumstances, in consequence of the difficulties caused by the shallowness of the Arbroath harbour.

996. Are the Board to understand that while the harbour remains at its present limited depth every vessel bringing cargo there is subject to a higher freight from the additional risk from shallow water?—Yes; small vessels are put to inconvenience, and it frequently happens that vessels of large size cannot enter at all.

997. If the excavation were made, as proposed, from three to four feet, what additional tonnage do you expect that would admit?—I believe vessels of 400 tons would get into the harbour. This is more than double the tonnage of vessels that can be well accommodated now.

998. Would that additional tonnage increase your dues?—No doubt it would; it would increase the trade in every way.

999. Can vessels with easterly winds take this harbour as a harbour of refuge?—Yes.

1000. Do small vessels, in point of fact, take it now?—Yes.

1001. Is it expected that if the harbour was deepened to that extent that the ordinary coasting vessels would be able to take the harbour?—Yes. Vessels of 300 tons would come at any time, I have no doubt.

1002. Are there any means at the command of the Harbour Trust to excavate the harbour which is pointed out as being so necessary?—No.

1003. Upon what security has the money been borrowed?—When we commenced the improvement of the harbour nobody would lend money upon it; the security was thought to be doubtful; it was thought that the harbour would not stand, the works having to be constructed with so great an extension to the open sea. A public meeting was held, and appeals were made to the public spirit of the inhabitants and people in the neighbourhood, and they came forward some of them with their own money, and those who found it inconvenient to do

that came forward and granted personal obligations in support of the security the harbour was able to give, and they did that to the extent of about 25,000*l.*

1004. Are the Board to understand that of that 50,000*l.* borrowed, 25,000*l.* is on the personal guarantee of individuals connected with the port?—About 25,000*l.* of it is. There were other people who lent their money and took the security that the Harbour Trustees could give.

1005. What was the original estimate of the harbour when first projected?—50,000*l.* was the original estimate to cover every thing. 40,000*l.* was to execute all the works and make a wet dock in addition, and the remaining 10,000*l.* was the price of the old harbour.

1006. Then the difficulty you are in is from the execution requiring more money than you contemplated at the time of projecting the harbour?—Precisely. I may state that the foundations were made deep with the public object of securing a harbour capable of admitting larger vessels, which the trade of the port required.

1007. And the limited amount of shore dues prevents your borrowing more, while the harbour remains in its present state?—Yes.

1008. (To Mr. *Leslie.*) In what state are the works at the present moment; do you consider them likely to be stable?—All the works are perfectly stable and substantial.

1009. Do you consider any further outlay would be necessary than in deepening?—No.

1010. What is the area of that harbour?—Six acres.

1011. Would the estimate you have given in enable you to complete the whole harbour, as originally proposed, or only the deepening?—Only the deepening.

1012. What additional sum would be requisite to finish the inner docks?—About 25,000*l.* including a pier on the north side of the entrance.

1013. What is the accommodation now without that new dock?—At present there are two tide harbours, and it is proposed to convert one of them into a wet dock. The whole area will not therefore be increased.

1014. As an engineer are you confident that these works will stand the sea?—I have no doubt of it.

1015. And that nothing is wanting to render the harbour available for vessels of the usual size frequenting the port, but deepening the approach?—I think not.

1016. Are you quite confident that the sum of 9000*l.* you have given in your estimate is adequate to remove the rocks to the extent you have stated?—I think so.

1017. Is there no danger when once excavated of being again filled up?—There will be a filling up in the interior of the harbour, but there is not any danger of the entrance filling up.

1018. (*Chairman.*) What is the cause of the interior filling up?—There is a small stream, which comes down and silts the harbour.

1019. Do you think a small dredging power would keep it down?—I think it would; we keep it down now by hand dredging.

1020. (Mr. *Hume.*) (To Mr. *Macdonald.*) What will be the depth of water at the entrance if deepened as proposed?—Ten feet at half-tide, both at springs and at neaps.

1021. To what extent, if that deepening is made, would it serve as a Harbour of Refuge for the usual vessels which pass along the coast?—Strictly speaking it would not be a Harbour of Refuge, but it would afford valuable shelter for all vessels not drawing more than 10 feet water, which is probably the usual average along the coast, at half-flood, and therefore for six hours out of the 12 it would be fully available as a Tidal Harbour of Refuge.

1022. Would it be possible to take the harbour during the night at that time of the tide?—Perfectly possible, if properly lighted.

1023. There are lights?—Yes, there are harbour lights.

1024. Are you aware whether those lights are properly situated to enable them to take the harbour at that time of the tide?—The lights at present are properly situated, but in the event of deepening the approaches they might require to be altered accordingly.

1025. From your knowledge of the coast is there much need of a Harbour of Refuge at that port?—Very great indeed. The greater part of the east coast of Scotland is well known as an iron-bound rocky coast, and with the wind on a lee-shore, is extremely hazardous. In strong north-west winds, too, which blow right out of the Tay, vessels commonly run down off Arbroath to get under the shelter of the land.

1026. Do you consider that the deepening of that harbour would be productive of benefit to the coasting trade generally?—Of so much benefit that I think it may be fairly stated as a subject of public importance.

1027. Do you consider that deepening it to the extent that Mr. Leslie has stated, of only three feet, would be adequate, if you look to it as an object of public importance?—Certainly not sufficient for all purposes, but as I have stated, to render it a very valuable shelter during six hours out of the twelve, for the greater part of the vessels that frequent that coast, and when the frequent distressing wrecks that occur on that coast are considered; for as I am informed, that about the year 1800 not less than 13 vessels were wrecked in one night in the short tract of coast between Arbroath and Red Head, only six miles to the north-eastward, I think we are fully borne out in the statement.

1028. If it should be deepened, would you limit the deepening, or would you extend the depth?—By all means extend the depth. The only possible excuse for not exceeding three feet would be the very limited means at the disposal of the trustees, but if Government were to give a small grant in aid of improvements at the entrance of Arbroath, I would then strongly recommend deepening from eight to ten feet, if, upon examining the slope of the shore, it should be found there was no great difficulty in doing so.

1029. Beyond the 700 feet to which you propose to excavate what water do you come

Mr. *J. Macdonald* and Mr. *James Leslie.*

May 21, 1845.

to?—Into 18 feet at one cables' length distance, and six fathoms at a quarter of a mile beyond.

1030. (*Chairman.*) On the chart there is a rock to the eastward, called Knuckle Rock which is covered at three feet rise of tide. In the event of improving the harbour is it of sufficient size on which to erect a light or beacon?—Yes, and I should recommend that and another beacon on the Cheek Bush to the south-west as very useful guides into the harbour.

1031. (Mr. *Hume.*) Would not such beacons be excellent guides to ships?—Yes.

1032. (Mr. *Chapman.*) In making this harbour so good as you have described, do you think the Legislature would sanction a passing toll in its support?—I hope not; I should be sorry to see any more passing tolls on shipping for any circumstances whatever.

1033. Do you think the Government would consent to a grant to this individual harbour in preference to any other?—I do not recollect at this moment that any harbour with which I am acquainted on the coast of England has similar claims. The trustees of Arbroath Harbour have expended 58,000*l.* in improving it internally; and all that is now required is, to deepen the approaches to enable them to turn that depth to account; and considering the size of the town and the means at their disposal, I do not remember any place that has made so great a sacrifice as have the trustees of this harbour.

1034. (Mr. *Hume.*) (To Mr. *Macdonald.*) Is there not a railroad from Arbroath to Forfar?—Yes.

1035. Has not the trade of Arbroath been considerably increased by that means?—It has.

1036. Do you consider that deepening the harbour as now proposed, would tend to increase that traffic?—I do.

1037. And ultimately the dues might be able to pay off the debt contracted, for which individuals are privately responsible?—I have no doubt it would.

1038. If the harbour is not deepened, do you consider the Commissioners will be able to meet the charges upon them and pay off any portion of the amount resting on personal responsibility?—I do not think they will be able to keep the harbour up sufficiently and pay the debt, unless they get it deepened.

1039. Are the Board to understand that the harbour, on which 58,000*l.* has been already expended, will deteriorate, and a great portion of its benefit be lost, unless that sum is expended?—I think so.

1040. (Mr. *Chapman.*) Did the Government afford any facility or assistance in making this railway by any grant of money?—None.

1041. It was raised through the exertions of the shareholders?—Yes.

1042. (*Capt. Washington.*) Did not the trustees purchase the harbour from the Corporation of the Borough?—Yes.

1043. Did they not throw it open to the public?—Yes.

1044. (Mr. *Hume.*) Have you received any assistance from the Government in any way towards the formation of this harbour?—None whatever.

1045. By what means have the Harbour Commissioners been able to raise so much money?—I have already stated how much the inhabitants of the town and neighbourhood assisted the trustees in raising money. The first thing that was done was the acquiring of the harbour from the Corporation: it belonged to them, and they had the revenues of it for municipal purposes. Meetings of the inhabitants were held, and a proposal made that the Corporation should surrender the harbour. They said they could not do so, because they would have no means of paying the watching, paving, lighting, and other expenses of the town, which they were in the habit of doing out of the surplus revenues. Then the inhabitants met, and resolved that they would adopt the provisions of the General Police Act for Scotland, which give powers to tax the inhabitants for all these purposes. They told the Corporation, "If you surrender the harbour we will tax ourselves by adopting this Act;" and by that means, to the best of my recollection, 1400*l.* or 1500*l.* a-year was raised for expenses which used to be paid entirely out of the revenues of the harbour, and now the inhabitants are paying that sum yearly, in order to get this harbour made efficient. They are paying yearly a large sum of money, and will continue to do so. That was the first step taken. The inhabitants had previously been solicited to adopt this Act, and they rejected it. When it was put to them in this form, "You will get your harbour improved," they agreed to tax themselves for that purpose. The whole community agreed to it, and now continue to tax themselves; and I think about 1400*l.* a-year is raised for these purposes.

1046. (*Capt. Washington.*) Do the trustees derive any emolument from their office?—None whatever.

1047. None of the Commissioners are salaried?—None.

1048. All their services are gratuitous?—Yes.

1049. (Mr. *Hume.*) By whom are the Commissioners appointed?—Two of them are appointed by the town council of Arbroath, and the Provost of Arbroath is a Commissioner *ex-officio*, two elected by the town council of Forfar, and ten are elected by the 10*l.* Parliamentary voters of the borough of Arbroath, and four elected by the freeholders of the county, making in all 19.

1050. (*Capt. Washington.*) Are any of those ship-owners who have been at sea?—Yes.

1051. Who takes the general management of the harbour?—The trustees.

1052. (Mr. *Hume.*) Do they hold regular meetings?—Yes; they have stated meetings every month according to a standing order, and they are regular in their attendance. They have also standing committees, who hold frequent meetings.

Mr. *J. Macdonald* and Mr. *James Leslie.*

May 21, 1845.

1053. Do they publish an account annually of their receipts and expenditure?—They do; they are printed, published, and circulated.

1054. Has every individual belonging to the towns of Forfar and Arbroath a right to have their accounts and examine them?—Yes.

1055. Are there auditors?—An auditor is appointed by the trustees annually as a body.

1056. Are the auditors paid anything for their duty?—Yes.

1057. (*Capt. Washington.*) What is the population of Arbroath?—About 15,000.

1058. (Mr. *Hume.*) What does the trade chiefly consist in?—Flax-spinning and manufactures.

1059. Coals?—There is a great import of coals and flax.

1060. And export?—Canvas and brown linens, stones for pavement, and corn.

1061. Arbroath itself and the district around are manufacturing districts?—Yes.

1062. Thread and flax-spinning?—Flax-spinning, and manufacture of canvas and brown linens.

1063. (Mr. *Chapman.*) What is the number of individuals who have given their personal responsibility for the payment of this money?—I think, from recollection, about 60.

1064. In the event of any advance being made by Government, would those gentlemen look for a return of the money for which they have become responsible?—I think not.

1065. They will still keep up the responsibility?—Undoubtedly. What they want is to make what is done effectual; it is not to relieve them.

1066. (*Chairman.*) They would hold those securities as a sort of debenture?—They remain effectual.

1067. You say you apprehend that if the harbour is not improved, the trade will deteriorate. Why should it not remain as it is now?—The inner portion of the harbour is filling up.

1068. (Mr. *Hume.*) Is any portion of the trade going to Dundee, in consequence of the harbour not admitting larger sized vessels?—Yes; and that adds to the expense to the people who are getting goods, because they have to send them overland to Arbroath.

1069. (Mr. *Chapman.*) What number of vessels entered the port of Arbroath five years ago, and what number entered last year?—In the year ending 15th October, 1840, there were 777 vessels, and 48,193 tons.

1070. What was the number in 1844?—The number of vessels was 749, and the tonnage 47,647.

1071. How does that tally with the number of ships that entered the same port ten years ago?—I have no means of answering that question.

1072. From your recollection, has it increased or diminished?—I should say it has increased.

1073. Notwithstanding the badness of the harbour?—Yes.

1074. It has continually increased?—Yes.

1075. Have the manufactures increased also?—Yes. I would add that during the winter before we got any use of the enlarged harbour, on various occasions, I should say nearly a dozen times, we could not receive another vessel; the port was so crowded that they were obliged to go to other places.

1076. (Mr. *Hume.*) Is not Arbroath a free port?—Yes.

1077. Having a custom-house to itself?—Yes.

1078. When was that established?—About a year ago.

1079. (Mr. *Chapman.*) What is the amount of harbour dues a vessel of 200 tons would pay?—The dues authorized to be levied by the schedule of the Act vary from 1½*d.* to 1*s.* 6*d.* per register ton.

1080. (*Chairman.*) Is the scale of duties regulated by the ports from whence the ships come?—Yes, whether they are foreign or coastwise. The amount levied on the goods is the same, but on the ships it varies.

1081. (Mr. *Hume.*) Have you any further statement to make?—I would mention that there is a balance of about 3000*l.* remaining unpaid; after all our money was gone, we were indebted to the contractors to that amount. Meetings were held, and appeals made to the Corporation and inhabitants again, and it was resolved, as there was no remedy, that the Corporation should assist them; and they have given their security for that in addition.

1082. If the money which you seek was advanced, every farthing of it is to be applied to the excavations and improvements pointed out?—Yes.

1083. The responsibility of the persons you have alluded to for the money already expended, must remain until the improved revenue of the harbour is sufficient to pay them off?—Yes.

1084. (To Mr. *Leslie.*) With regard to the information you have given as to deepening, have you anything further to add?—I would add that a general increase of three feet will give an increase, as far as regards the vessels, of probably five feet in many places; we may perhaps take off five or six feet from high places, and not more than a foot or two from low places.

1085. Are you quite confident that upon that estimate the deepening could be made so as to give the great facility of entrance you have pointed out?—I have no doubt of it.

[*The Witnesses withdrew.*]

Adjourned till 1 o'clock on Friday next.

Friday, 23rd May, 1845.

Mr. *P. Stead* and Lieut. *F. Wilson Ellis,* R.N.

May 23, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Capt. Sir G. BREMER, K.C.B.	Capt. BEAUFORT, R. N.
Mr. HUME, M.P.	Mr. GODSON, M.P.
Mr. RICE, M.P.	Capt. WASHINGTON, R.N.
Mr. A. CHAPMAN, M.P.	

Mr. *Patrick Stead* of Halesworth, and Lieut. *Francis Wilson Ellis,* R.N., Harbour Surveyor of Southwold, } sworn and examined.

1086. (*Chairman.*) (To Mr. *Stead.*) What is your profession and place of residence?—A merchant and maltster at Halesworth. I possess freehold malt-houses and trade property. I pay this season above 20,000*l.* in malt duty to the Crown.

1087. Are you in the habit of trading to the port of Southwold, and for how long have you been so engaged?—I am, and have been in the habit of doing so since 1817.

1088. How much corn or malt do you export, and what coals do you import?—I shall export this season upwards of 20,000 quarters of malt and corn; of coals somewhere about 3000 tons; in some years we have more than 3000 tons, and in some years less.

1089. Who pays the chief dues of the port of Southwold?—I consider that the merchants pay them; and for this reason—the merchant hires the vessel; the captain pays the dues on corn and goods at the port; and, accordingly as the captain pays those dues, he charges; if I have coals through Southwold, I pay the Southwold dues. Again, if I had coals through Yarmouth, I should pay the Yarmouth dues and the carriage towards Southwold.

1090. Have you any complaint to make against the present state of the harbour?—I have made very serious complaints about the state of the harbour for very many years.

1091. From your own personal knowledge?—Yes. We have had very often a very bad bar.

1092. (Mr. *Hume.*) There is a letter addressed by you to the Admiralty on the 28th of June, 1844, complaining of the state of the harbour—did you write that as your own act, or at the request of any portion of the inhabitants of Halesworth?—I wrote it because I received great inconvenience in trade; but my neighbours received equal inconvenience.

1093. Was it in conjunction with them, or by your own act?—I believe it originated with myself.

1094. (*Chairman.*) Have you reason to believe, from your own knowledge, that the harbour was formerly in a better state?—Since 1817 I cannot say that it has been in a much better or a much worse state, but I heard the evidence given before the Commissioners of Southwold Harbour, and of the River Blyth in August, 1839, who took evidence at the town-hall of Southwold, and advertised for evidence once a-week for four weeks; all of which is printed.

1095. (Mr. *Hume.*) Were you present when William Blanden, of Halesworth, was examined?—Yes.

1096. Is it upon that evidence that you mention the former state of the harbour?—That is one of the evidences; he is the oldest man I am aware of on the river.

1097. State the result you have gathered from all that evidence?—Blanden stated "that he was 70 years of age; that he had been a wherryman between Halesworth and Southwold, 59 years; that about 50 years ago ships traded at Southwold of similar size as now trade there, and he never remembers being detained there for want of water, or upon the bar, until after the marshes on the banks of the river were taken in; that the wherrymen among themselves said, and considered at the time of the embankments being made, they would ruin the harbour, which, up till then, had been good. That no better harbour ever wanted to be up to the date of the embankments; that the tides 40 or 50 years ago ran a wonderful deal stronger than now, when we always required to bring up our wherries with an anchor, but now we find a quant (pole) is quite sufficient. That about 40 or 50 years ago he went pinpatching over the marshes called the Salts and Flats."

1098. Are they now dammed out from the flow of the tide?—I believe they are; that they were always under the waters at neap tides and spring tides; that there was a large creek and a great deal of water in it, where he had been up with his craft pinpatching. "I never was questioned about or refused; all the public went as a matter of right, and asked nobody at all; we took our own leave, and nobody said anything to us." He remembers the 200 or 300 acres being embanked, and that since that time the harbour had been getting worse and worse, and that there has not been back-water enough to keep the harbour scoured out; the tide not being nearly so strong now as 40 or 50 years ago. "I could now run my wherry down against the flood with a fair wind double the distance what I could have done with a similar then. We never had to go to the roads or bay in old times to lighten the ship, as they got in then without lightening, and come and lay along side the piers afloat. That the ships used to come in as soon as it was flood upon the bar, and would get over it in an hour or two; larger ships came in then than now ("The British Laurel" and "Old Providence.") The only thing that can be done now, is to get more back-water, and to run out the north pier 40 or 50 yards."

1099. Does the other evidence support the opinion given by Blanden?—Some of it varies, but generally speaking I think it does.

1100. (To Mr. *Ellis.*) Are you of opinion that the majority of the evidence taken upon that Commission was, that in former times within the memory of man, the harbour was deeper, the current stronger, and the bar less than at the present moment?—That is the effect of the evi-

Mr. *P. Stead* and Lieut. *F. Wilson Ellis*, R.N.

May 23, 1845.

dence given, although I do not concur in it. I have known the place only about fifteen years, and therefore cannot speak from knowledge beyond that time. I would make one observation with respect to the evidence. Blanden says, "We never had to go to the roads or bay in olden times to lighten the ships, as they got in then without lightening, and I have seen ships drawing nine or ten feet water come in at half flood, and come and lay alongside of the piers afloat." It is a known fact that the harbour was so bad formerly that the masters of the ships built a lighter for the express purpose of going out to lighten their vessels in the roads before they could get into the harbour.

1101. (*Chairman.*) Do you speak from your own knowledge?—That lighter was in existence when I went to Southwold; it was purchased by the Commissioners of the harbour from the masters; it was used as a ballast lighter at the time I went there.

1102. Are you prepared to speak from your own knowledge, of the age of the vessel, and the purpose for which she was originally intended?—She was used before I went there for the purpose of lightening vessels; and I can show, I think, from documentary evidence, that she was used for that purpose.

1103. (Mr. *Hume.*) Are you prepared to say that larger vessels did not come into the harbour formerly, than can come in now?—No.

1104. Do you mean to say there were not larger ships?—I cannot say whether they were larger or smaller; I should say there were larger vessels formerly, because I think the harbour must have been better formerly, before the river was curtailed by the encroachment of the sea. (Mr. *Stead.*) I would remark that the meeting at Southwold being public, and advertised in the public papers, it was open to any person to bring in evidence of any nature, and to be examined before the Commissions sitting there in the public hall, but I am not aware that any evidence was brought in that said that that lighter was used. (Mr. *Ellis.*) The Commissioners of Southwold Harbour brought forward no evidence. The Commissioners of the River Blyth memorialized the Commissioners of Southwold Harbour upon the bad state of the navigation. The Commissioners of the Southwold Harbour, at the suggestion of the River Blyth Commissioners, appointed a committee for the purpose of receiving evidence; but there was no evidence brought forward to rebut anything that the River Commissioners alleged in their evidence.

1105. (To Mr. *Ellis.*) Do you consider that Committee would have done their duty if they had not obtained the best evidence they could from all parties?—The Committee was called for the purpose of receiving the evidence of the River Blyth Commissioners and such others as might be offered. No other evidence was offered that I am aware of in reply to the River Blyth Commissioners.

1106. Did you attend that Committee?—I did; I attended as secretary, and took down the evidence.

1107. Were you aware at that time of the fact that you have now stated, that that lighter was so used?—Yes.

1108. Why did you not bring evidence to that point?—The thing is so notorious in Southwold, that the question has never been raised or contradicted.

1109. In what way is it notorious?—I will show it in print. This is a book called "A Hand-book to the Port and Shipping of Southwold," printed in the year 1842. It is ostensibly written by Mr. James Maggs, but is presumed to have been written by Mr. Jermyn, the former collector of the harbour under the Southwold Commissioners, whom I succeeded. He says "that previous to the year 1790, few vessels belonging to the port were able to pass the bar with full cargoes; and that in that year the masters and owners of the principal vessels had a lighter called 'The Good Intent,' built at Yarmouth, for the purpose of taking out part of their cargoes in the bay, to enable them to enter the harbour."

1110. What sized vessels does he allude to?—The vessels of the port, which range from 70 to 80 tons.

1111. Does he mention them to be vessels of 70 or 80 tons?—No, he does not.

1112. Then, upon what authority do you state that; you say you have only been 15 years there?—I presume they were 70 or 80 tons vessels of the ordinary tonnage trading to the port.

1113. They may have been colliers from Newcastle?—Newcastle vessels come there but rarely. I offer the passage I have read, not as evidence of the size of the vessels, but that a lighter was employed for the express purpose of lightening the vessels. There is one expression that bears on the question:—"The cost of the 'Good Intent' exceeded 200*l.*, and it was for many years a very profitable concern; as most of the vessels resorting to the port made use of it. Upon the extension of the South Pier in 1806, however, the bar was found to be so much improved by it that vessels with full cargoes entered without difficulty; the lighter became altogether useless and unprofitable, and was sold in 1815, by those for whom it had been built, to the Commissioners of the haven, for about a fourth of its original cost, to be used as a dredger upon the shoals of the river." That lighter was sold when I first went to Southwold. —(Mr. *Stead*) Mr. Jermyn is an interested individual, inasmuch as he was the collector.

1114. (*Chairman,*) (To Mr. *Stead.*) Have you made representations as to the neglected state of the harbour, and have those representations been paid attention to?—The first representation I made was on the 4th of August, 1827. I was then getting deeply into the interest of Southwold, because I was extending my trade in malthouses. I found the quality of barley good for the purpose for which I wanted it, and I increased them on that account. In 1827 I began to pay active attention to the harbour of Southwold, and I wrote to Mr. White, the clerk of the Commissioners. I urged them to adopt public open contracts like Yarmouth and other places; I urged them also to straighten the course from Walberswick Quay to the South Pier, and remove the Billar Shoal, contracting the passage on the north, would leave a strong hope that the channel and bar would be infinitely benefited. On the 13th of September, 1828, I wrote about the accounts; I wanted to get the accounts. On the 25th of September, 1828, I urged them to dredge the harbour, and I took over Mr. Crane, who was the

Mr. *P. Stead* and Lieut. *F. Wilson Ellis*, R.N.

May 23, 1845.

resident inspecting engineer at Yarmouth, with me, to get his opinion, as he had improved Yarmouth harbour wonderfully. He pointed out a cut through what is called the Bellar Shoal would do a great deal of good to the harbour, and to straighten the course of it. I told them there were 29,655 quarters of corn shipped annually at Southwold, and that the loss sustained I valued at 1*s*. per quarter, from the want of dispatch, making 1452*l*. 15*s*., and that one-half part of the trade was diverted to other channels, making 2965*l*. 16*s*. per annum loss.

1115. What was done?—Nothing was done, but they went to Parliament for a new Bill.

1116. You are speaking of the Southwold Commissioners?—Yes.

1117. In coming to Parliament, did you make any efforts to improve the harbour?—I made all the efforts I could to get a good bill, and to get Commissioners appointed by the traders, payers of dues, and growers of corn.

1118. Did you get that effected by the Bill?—I did not. The corporation of Southwold, The bankers, merchants, shipping owners, The Commissioners of the river Blyth, growers of corn attending Halesworth market, and myself, presented petitions to the House of Commons, praying them to introduce a similar constitution of Commissioners as were in other harbours such as Glasgow. Liverpool, Dundee, Newcastle, and Leith. I asked them to introduce Commissioners who were to be appointed by the several traders, because I thought they would attend more to the harbour than we could expect gentlemen to do in the country whose station in life does not lead them into those accounts that merchants and traders are familiar with.

1119. What was the first Act for regulating the harbour of Southwold?—That of 1746.

1120. What was the character of the Commissioners appointed by that Act?—The bailiffs of the borough, 12 proprietors of the adjoining lands, and one clergyman.

1121. Had the town of Halesworth the appointment of any portion of the Commissioners?—None. They were to be self-elected.

1122. In any of the subsequent Acts had the town of Halesworth the appointment of any portion of the Commissioners?—Never. Self-nomination and election was the constitution.

1123. In 1830, when you came to London, you have stated that you endeavoured to obtain a kind of representation of the interests of the town in the new Bill?—Yes.

1124. You did not succeed?—I did not.

1125. How many Commissioners were appointed by the Act of 1830?—Thirty-two.

1126. What class of persons were appointed, and are now Commissioners?—The class of persons who were appointed by this Act which I took so active a part in were all landed proprietors, with the exception of two, and those two happened to be at the time, I believe, the bailiffs of Southwold. There was a strong objection made to the bailiffs being introduced into the Bill, and that strong objection was met by a petition from the borough of Southwold, convened in the public hall.

1127. What date?—In the spring of 1830. This following resolution was passed by acclamation. Resolved unanimously in the Common Hall of the port and borough of Southwold, that the corporation seal be not attached to any consent or grant of lands, beach, or other right required by the Bill in its present shape. And that no such grant shall be allowed till a full, fair, and equal representation of Commissioners be introduced in the present or any future Harbour Bill of the borough of Southwold, of merchants, ship-owners, and landed proprietors to be elected annually; and a petition was then agreed on, praying "That the bailiffs and commonalty of the borough of Southwold may be empowered to nominate and elect from time to time six Commissioners to be appointed under the said Act." A meeting was afterwards held, and the following petition was the result of the merchants, ship-owners, ship-masters, and others of Southwold, that the bailiffs for the time being for the borough of Southwold may be restored and inserted as Commissioners. "That the clause appointing the Commissioners in the said Bill may be expunged, and one of a more open character introduced. That the nomination and appointment of Commissioners be not confined to the extent of landed interest, or the amount of interest derived from land as required by the said Bill only; but that the said Commissioners may consist of merchants, ship-owners, and payers of dues equal in number to those representing the landed interest." That all such Commissioners be elected and appointed from year to year only; also a petition from the merchants, &c., of the river Blyth and inhabitants of Halesworth, who pray that inquiry may be made "whether the embankments of the lands and the stopping up the creeks have been necessarily and equitably made, as the prosperity and goodness of the harbour depend so especially thereon."

1128. Did you come to Parliament to enforce those resolutions?—Repeatedly.

1129. Did you obtain any alteration in the Commission?—The bailiffs, I think, were introduced into the Bill at that time as bailiffs upon the third reading, and Clause A limiting the port added.

1130. Who were constituted Commissioners by the Act of 1830; what class of people were appointed?—Landed proprietors, clergymen, all justices of the peace for the county, and bailiffs of Southwold.

1131. How many of each?—All the justices of the peace, fourteen clergymen, and sixteen landed proprietors (two bailiffs of Southwold, who were merchants), are named in the Act.

1132. Has there been any alteration in the character of the Commission since?—They have introduced a few more merchants since that time.

1133. What is the state of the Commission now?—All the justices of the peace, ten clergymen, seventeen landed proprietors, their lawyer, one merchant, one brewer, and one chemist. (Mr. *Ellis*.) By the Municipal Bill, the town council have the power of electing two *ex officio* Commissioners of the harbour, and they require no property qualification. (Mr. *Stead*.) By section 7 of the Act. "If any person not being so qualified, or not having taken the said oath, shall presume to act, every such person shall for every such offence forfeit and pay the sum of 50*l*."

1134. (To Mr. *Ellis*.) Do you know that all these clergy are qualified with an income of

100*l.* a year from land as formerly in the Act?—I apprehend so. I apprehend they are completely within the terms of the qualification.

1135. As landed proprietors?—Not as landed proprietors, there is a double qualification.

1136. Have you attended any of the meetings of the Board of Commissioners?—Every meeting.

1137. Can you state what portion of the clergymen attend every meeting?—On Saturday, 15th July, 1843, there were present four clergymen out of twelve Commissioners.

1138. How many belonging to the town?—Two.

1139. Is that the general character of the meetings?—I should say generally so. On the 20th of July, 1839, there were present three clergymen out of twelve Commissioners.

1140. How many of the town?—Three.

1141. (To Mr. *Stead.*) As the inhabitants were unable to obtain that modification of the Bill, have they been satisfied with the management of the harbour ever since?—We have been very much dissatisfied with the bar. I had two vessels loaded with corn bound for Newcastle and Perth in 1838, called "The William," and "The Hawk," under a hundred tons burthen; they were detained; they were lost afterwards, one with all hands on board, and the owners ascribed the loss to that detention because it threw them into that dreadful gale which occurred in January, 1839.

1142. Do you mean that they were only able to leave the harbour at high spring tide?—Not even at high spring tide could they leave the harbour. Other vessels were detained at the same time; I have had six or seven detained frequently. On one occasion, in 1838 or 1839, we had the harbour beached up so high and dry that carriages and horses passed outside of the pier head.

1143. Do you mean that the bar had been raised in 1838 so high that persons could walk across?—In 1838, or 1839, not only persons, but even horses and carriages for many days. A great number of vessels were inside; no water ebbed in or went out; it was a perfect lake; and then there was a number of vessels inward bound that could not get in, beating about for shelter in Yarmouth Roads, &c., one stranded and lost totally on the bar called "The British Queen."

1144. Had that bar been thrown up by an easterly gale?—As I do not live at Southwold I forget how it happened. The want of back-water was not sufficient to keep the harbour open.

1145. Do you mean to say that any impediment to the flow of the tide up the river had caused that?—I mean to say that a continual accumulation of tide after tide bringing in beach choked it up, while I should imagine if we had had the natural backwater, and it had not been banked off, that water would have been sufficient to keep the harbour open.

1146. How was that tidal water banked off?—It was banked off by gentlemen in the neighbourhood whose land adjoined; they enclosed the land on each side of the river.

1147. To what extent has that been done?—In order to speak correctly I will state it from Mr. Walker's Report, "Showing the area of the embanked lands, formerly overflowed by the tidal waters of the River Blyth; with their situation and level below a six feet six inch tide, and the quantity of backwater excluded thereby from scouring the harbour."

1148. State the total area and the total amount of water excluded?—1504 acres of marshland, surveyed, excluded 148,296,490 cubic feet of water; of marshes which he did not survey, 1200 acres, if at the same levels, excluded about 118,637,192 feet. The total quantity embanked was 2704 acres, and the total quantity of water excluded was 266,933,682 cubic feet.

1149. Do you, and the inhabitants with whom you have communicated, consider that the injury done to the navigation to which you have alluded, has been caused by these lands on each side of the river being embanked, so as to exclude the flood tide?—Yes; we do believe that is the cause of the harbour being so bad.

1150. Do you know under what authority these lands have been enclosed?—I never heard of any authority whatever.

1151. (To Mr. *Ellis.*) You have seen Mr. Walker's Report?—Yes.

1152. Are you aware of the inclosures to which that Report alludes?—I know the inclosures described in Mr. Walker's Report.

1153. Do you know by what authority the inclosures took place?—I apprehend that the landlords inclosed them, considering them as their own property. I know there is an Act of Parliament which prohibits any embankment being made, which was passed in 1806, but none previously to that.

1154. What Act do you allude to?—It is the 46th of George III., chap. 153. It is intituled "An Act for the preservation of the Public Harbours of the United Kingdom."

1155. Is it a general Act?—Yes, for all the harbours of the United Kingdom.

1156. (Mr. *A. Chapman.*) That relates to the jurisdiction of the Admiralty over harbours?—Yes.

1157. (Mr. *Hume.*) Has any of these inclosures taken place since 1806?—Very immaterial ones, as stated by Mr. Walker.

1158. Up the river?—I am not aware of any up the river.

1159. (To Mr. *Stead.*) In offering the opinion you have given of the injury done by inclosing those lands, can you give the authority of any engineer for that opinion?—Mr. Rennie's, on the 6th of January, 1820.

1160. To whom was that made?—Addressed to the Commissioners of the Harbour of Southwold.

1161. What is the purport of that?—"There is little doubt that the harbour of Southwold has, at former periods, been of a much greater depth than it now is, as will hereafter be shown; and that for many years past it has been getting gradually more shallow, owing to the embankment of the salt marshes, over which the tide used to flow, and the stopping some of

Mr. *P. Stead* and Lieut. *F. Wilson Ellis*, R.N.

May 23, 1845.

the creeks which communicated with the channel of the river Blyth. By these changes the influx of the tide water has been diminished, and consequently the efflux thereby diminishing the velocity of the current, so that the matter which formerly was not sufficiently heavy to resist its strength, gradually became so.

1162. Is that the opinion you allude to in support of that which you have now stated as causing an injury to the bar?—That and many other opinions besides.

1163. Does Mr. Rennie afterwards state at that time the quantity of land that had been embanked?—He says that about 1100 acres of ground, over which the tide used to flow, have been embanked.

1164. What depth of water flowed over the marshes?—I can only refer to Mr. Rennie's report, who takes an average over 1100 acres at that time.

1165. (*Capt. Washington.*) Did Mr. Rennie survey and carry a level over the whole of the river and marshes?—No, he did not.

1166. Did Mr. Walker take the levels?—Mr. Walker had two assistants down there several months taking levels and measuring the land.

1167. What was the general result of his survey?—The result of Mr. Walker's survey is the table given above in answer to Q. 1148.

1168. (Mr. *Hume.*) What evils does Mr. Rennie point out as likely to arise from embanking the marshes?—"The quantity of surface contained within the present embanked channels of the River Blyth, creeks, and low embanked ground connected with it, as far as I can ascertain, may be about 200 acres, on a part of which the tide may rise five feet on the average; on others, not two feet; perhaps if four feet are taken it will be a full average; and if six inches only are taken as the average height, that the tide formerly flowed over 1100 acres now embanked, the diminished force of the current will be nearly in the proportion of ten to four. This is confirmed by the evidence of John Church, formerly a branch pilot but now master of a vessel, and who has been about 52 years at sea. He said that above 30 years ago the current of ebb was so strong that they were obliged to make the vessel fast by cables, and a boat could not pull up the harbour; but that now a vessel could stem the current with a good tow-line, and a four-oared boat could row up at any time. I have been thus particular in stating the evils arising from embanking the marshes, over which the tide used to flow, that I may impress on your minds the necessity of preventing such embankments in future, unless a receptacle is made somewhere else in lieu of the embanked lands; for unless this is strictly attended to, the harbour will go on getting worse until it will be entirely lost, and I am not aware that any remedy can be substituted for the deprivation of back water. To destroy the embankments already made, and to allow the tide-water to flow into its ancient receptacles, is no doubt the most obvious and effectual remedy that could be devised."

1169. Does he afterwards allude to any remedy for that beach which you say grew up into a bar?—"I am not aware of any means by which this beach could be kept out; but if the backwater were sufficient, what was brought in by the tide would be scoured away in the ebb;" and then he recommends a steam-dredging engine to scour away the shoals that would arise.

1170. Is there any other surveyor whose opinion you can state?—No other surveyor; but most of the captains and other evidence recommended such like.

1171. Has that recommendation of Mr. Rennie, with regard to embankments, been attended to?—There has been nothing done to abate it.

1172. Has any new embankment been made since that time?—I think there is a little made, about 36 acres of land near Southwold are enclosed.

1173. What do you consider ought to be done to remedy the present state of the harbour?—The same remedy that was applied at Wells, that is to take the banks down.

1174. What case do you allude to?—A case at Wells. It was decided upon an opinion given by Mr. Serjeant Grose, on the 31st January, 1778.—(*App.* p. 166.)

1175. Was the right of taking down those embankments contested?—It was contested in three several trials at law.

1176. What was the result?—They took place from 1779 to 1784.

1177. What was the opinion of Mr. Serjeant Grose on that occasion?—"I am of opinion that all the embankments which by preventing the flow and reflow of the tides, stop up the harbour, and are prejudicial to the navigation, were nuisances at the time they were made; but some of them have existed so long that there will be some difficulty in getting them removed. The best way to attempt it will be by indicting those persons who have made or continued the last of the embankments which are prejudicial to the harbour. It would be of too dangerous a consequence, I think, to attempt to abate them, by pulling them down, because the mischief might be infinite, and might be prejudicial against those who endeavour to remove the nuisance. I think the Commissioners under the Act for preserving the harbour, by virtue of that clause which enables them to do what they think fit for the purpose of improving and maintaining it, may apply as much of the money raised under the Act in support of such a prosecution will, in my opinion, be doing that which will assist to improve and maintain the harbour; but before such indictment be preferred, or any thing done towards removing the embankments, I would recommend an application be made to the Lord of the Manor, stating the inconveniences occasioned by the embankments, and begging him to remove them. If he sees the application in its right light, I think he may find out some plan to remove the nuisance complained of, without doing much injury to the land embanked, which would be the most desirable object on both sides."

1178. Does it appear that application was made to the Lord of the Manor?—Three several trials followed, and the result of those trials was, that costs and expenses to the amount of 562*l.* were paid by Sir John Turner, and there was an injunction granted by the Court of Chancery in 1781, restraining the Commissioners from removing the banks. This injunction was dissolved, and they were at liberty to throw down the same. After these proceedings, it appears

by a minute, that the water upon a spring tide flowed as far as the ancient limits of the port, by which we may infer that the banks were all removed. (*See Appendix*, p. 188.)

1179. Was the result of that trial to remove those encroachments?—It was.

1180. Have you any other decisions respecting Southwold?—Mr. Chitty's opinion was taken.

1181. At what time was that opinion taken?—The 4th of January, 1839.

1182. What was the occasion of his opinion being requested?—I found so much difficulty in my trade, that I put a case through my lawyer to Mr. Chitty.

1183. What is his answer?—"It appears to me under the circumstances stated, that the embankments and obstructions in question are public nuisances, as being an injury to the harbour and the passage of ships: (Callis, on Sewers, 76; Hale, De Jure Maris, 21; Hawkins, Pleas of the Crown, book i., chap. 32, s. 1—11.) As such nuisances, they may be abated and removed; or the erectors or maintainers of them may be indicted, or have a criminal information filed against them, or if any individual has sustained any special injury arising from them (as by the detention of his ships in the harbour, or the like) he might maintain a special action on the case against them: (See per Lord Ellenborough, R. *v.* Dewsnap, 16 East, 196; Greasley *v.* Codling, 2 Bing, 263.) Of these remedies, I should at all events for the present advise the adoption of the one by indictment only; which may be prosecuted at the instance of any individual who may think fit to resort to it. I should advise the indictment to be against the parties who have erected or maintained the most recent of the embankments causing the nuisance. I do not think that the length of time during which the embankments have existed will legitimatize them: (Weld *v.* Hornby, 7 East. 195; R. *v.* Cross, 3rd Campbell, 227; Coupland *v.* Hardingham, id. 398; Vooght *v.* Winch, 2 B. and Ald., 662. There is no limitation of time for the prosecution by indictment. The responsibility to an action at the suit of any person specially injured would cease at the end of six years from the occurring of that injury. Those persons who erected the embankments since the 46 Geo. III. was passed may, I think, have subjected themselves to the penalty imposed thereby. 4th June, 1839." (*For Case, see Appendix*, p. 188.)

1184. Did you on receiving that opinion take any legal measures, by indictment or otherwise, to remove the embankment?—I considered it was the duty of public Boards to do that, and not private individuals. I applied to the Commissioners of the River Blyth in 1839, and to the Admiralty, the Woods and Forests, and House of Commons, in 1844, and the result is the appointment of this Commission.

1185. You were at the expense of obtaining the opinion?—Yes.

1186. You did not think that you, as a private individual, should be put to the expense, but you applied to the Commissioners of the River Blyth?—Yes.

1187. When did you make the application?—On the 15th of June, 1839.

1188. What was the application you made?—I drew the attention of the Commissioners to the ruinous state that the harbour of Southwold has been reduced by the embankments of the marshes and stopping of the creeks, and submitted a printed report of Mr. Rennie, and I produced reports from various other harbours. They resolved to memorialize the Commissioners of Southwold, and the effect of that was, that the Blyth Commissioners examined six captains who were then in attendance; and those captains attributed the bad state of the harbour to the embankments. They conclude thus, "Finally all the captains declare that it is their decided opinion, the deprivation of back waters, occasioned by the embankments, causes the harbour of Southwold to be reduced to its present deplorable state. Further, that it is their unanimous opinion the extension of the old north pier and limiting the width of the present channel is essential to meet the now state of the back waters. And lastly, they admit the easterly winds have been lately more prevalent than usual; but still, that the state of the harbour has been getting gradually worse for several years past, and that if something is not done they must leave the port for elsewhere to obtain a livelihood.

1189. Did the Commissioners take any other steps?—They memorialized the Commissioners of the harbour, and the Commissioners of the harbour upon a meeting appointed a public investigation of the matter at the town hall of Southwold.

1190. Had the Blyth Commissioners any power of themselves to abate any of the nuisances by removing the enclosures?—I am not aware that they could have done it.

1191. What is the jurisdiction of the Commissioners of Southwold and the Commissioners of Blyth?—The Commissioners of Southwold Harbour have ample power to do all that is necessary.

1192. What is the extent of the jurisdiction upwards?—It is not defined.

1193. What is the jurisdiction of the Commissioners of Blyth?—They have gone down as far as Wolsey Creek.

1194. Do you understand that from Wolsey Creek to the sea is under the Southwold Harbour Commissioners?—I should think that it is.

1195. Is not the jurisdiction of the other parts under the Blyth Commissioners?—The Blyth Commissioners have performed their duty as far as it is necessary for the purpose for which they were established, that is, for the navigation of small boats.

1196. Are the Blyth Commissioners under an Act of Parliament?—Yes.

1197. (*Capt. Washington.*) Does the Act state for small boats?—When I state for small boats, it is for wherries.

1198. (Mr. *Hume.*) Under what authority do the Blyth Commissioners act?—Under the authority of the Act of 30th Geo. II., chap. 47.

1199. Have they any power of removing the embankments so as to improve the navigation?—The embankments do not interrupt their navigation for small craft so much as they interrupt the navigation of the harbour and bar.

[*The Witness withdrew.*]

Adjourned to Wednesday next at One o'clock.

Patrick Stead, Esq.

May 28, 1845

Wednesday, 28th May, 1845.

Present:—

Rear Admiral BOWLES, C.B., in the Chair.

Captain Sir GORDON BREMER, K.C.B.	Captain BEAUFORT, R.N.
Mr. HUME, M.P.	Mr. GODSON, M.P.
Mr. RICE, M.P.	Captain WASHINGTON, R.N.
Mr. AIRY, Astronomer Royal,	

Patrick Stead, Esq., further examined.

1200. (*Chairman.*) Will you be so good as to state generally any further complaint which you have to make against the river Blyth, and the harbour of Southwold?—I think that next to the removal of the embankments made by the landowners, which shut out the tidal waters, a dredging should take place, and an equalizing of all the sections of the river, and cutting of sharp corners, and above all the removal of Blythborough Bridge. Mr. Walker says "the bridge is a disgrace to the county and the navigation, and ought not to be tolerated another year."

1201. Will you explain why you consider the bridge an injury to the navigation?—Because the sectional area is too small; the sill is too high, and the soffit of the arch is too low. I have recommended the removal of that bridge for a long time. The trustees of the road would not consent to that, nor the magistrates of the county, although the trustees of the road have removed a bridge of far inferior importance, the removal of which cost a great deal of money, and it did not require to be removed; it tumbled down several times; it is called Wangford Bridge.

1202. (Mr. *Hume.*) What distance is that from Blythborough Bridge?—From three to four miles.

1203. (*Chairman.*) Is the new bridge so built that it does not impede the flow of the water?—It is a bridge over a part that communicates with another branch of the river that is not navigable, which it leads to the river. There is a large quantity of land which Mr. Walker does not map to the westward of Wolsey Bridge. That also would add greatly to the back water. Mr. Clissold, in his pamphlet, values such marsh land at 3*l.* an acre rent; some land he proposes to embank for the benefit of the harbour, called Buss Creek, and, he says, that there are 100 acres of it, and that it would be worth 300*l.* per annum on a rough estimate, that is, from Buss Creek and the lands adjoining. I have made a calculation of what the rental would be, if we could get that land for the benefit of the navigation; the quantity of land embanked altogether, according to Mr. Walker's account, is 2704 acres, and at 3*l.* an acre, it would be 8112*l.* per annum. According to the calculation, at 30*s.* per acre, the back rent due would be 317,498*l.*, reckoning the back rent according to the dates of the embankment, as stated in old Mr. Rennie's Report of 1820. I have asked the Commissioners to use a rake to deepen the river, such as was used in order to cut out the Victoria Channel at Liverpool, and such as is used at the West India Docks in London; that they should have a steam-vessel to tug out and in ships at high water, and rake out the mud at low water; and that they should build concrete faced with rubble work instead of wooden piers.

I reckon that the tides at Blythborough flowed about the same as they do now, that is, comparing the Report of Mr. Langley Edwards in 1757 with that of Mr. James Walker in 1840; therefore, it cannot be said that the embankment of land has raised the level of the tide, or carried it to a further extent up the river; and it is proved by the evidence printed by the Commissioners of the River Blyth, that the locks which were built upon the river did not commence until the river was beyond the influence or reach of the tide; the first two locks being built upon land which was purchased by the Commissioners, and through which the canal was cut, and Bulchamp and Blyford, the two lowest of the five locks, erected thereon. The Commissioners of the River Blyth have very much added to the quantity of back water, by deepening and widening and scouring the upper part of the river and by making a new cut, called Collinson's Cut; and, I think, that the River Commissioners have done all that was requisite for boats, but that the Harbour Commissioners have not done anything above the harbour for the benefit of the bar. I think that their expenses have been excessively high; as regards their establishment of officers they are double the expense of other ports, such as Wells and Yarmouth, compared with their revenue. I think that the dredging was done at double the expense that it ought to have been.

1204. What was the expense?—They paid 5¾*d.* for the lighters carrying the sand and mud from the dredging engine, whilst I believe it might have been done at 3*d.* a ton. At the river Tay, where I know dredging is carried to the highest perfection of any part of this kingdom, they do the whole of the work for about 2¼*d.* per ton, including every expense, the engine, machine boats, and everything; and I should beg leave to draw the Commissioners' attention to a pamphlet which I have printed and it is now laid on the table, containing a letter at p. 56, dated 23rd October, 1839, from Messrs. Wright and Currie, of Perth; and another at p. 57, from the managing man of the dredging department in the river Tay, dated 9th October, 1844, showing that the dredging was done in that river at from 2*d.* to 2¼*d.* per ton for gravel; and from 3*d.* to 4*d.* per ton for clay. (*See Appendix*, p. 168.)

The detention of vessels by the bar that were loaded by me, for want of water over the bar, has been excessive. I loaded the "Lord Exmouth" on the 6th of January, 1840. The cargo was landed out of condition, and she was reloaded with the 668 quarters of barley on the 19th

of February; she could not sail before the 4th of April, three months; that is a total destruction to any brewer's interest, because a brewer cannot malt barley in the summer months.

1205. What depth of water did that vessel draw, and what depth was there on the bar during that time?—I have not the information here, but I can get it.

1206. Of how many tons burthen was the vessel?—I suppose about 80 tons. I could enumerate 15 or 20 vessels that were delayed in a similar manner and stopped for various and long periods. It has been to that extent, that although I used to ship from 10,000 to 50,000 quarters of grain a-year at Yarmouth and at Southwold, &c. I have been compelled altogether to give up the trade of shipping corn.

1207. (*Chairman.*) When did this detention begin, and what was the state of the harbour when you first began business?—When I began business I lived at Yarmouth; we did not find so much difficulty at first, we found it growing upon us.

1208. (Mr. *Hume.*) What was the depth of water at first?—With the same class of vessels when first in business, I did not find so much difficulty as I did afterwards; the bar has been getting worse, and the complaints and losses which came upon me were so great, that I gave up the trade of shipping corn in 1840, and several merchants were ruined by the delay and loss of markets; they could not calculate what time would be occupied, and barley is of that perishable nature that after the month of April it is only fit for grinding.

1209. (*Chairman.*) You came to reside at Halesworth in 1817?—My business was in Yarmouth up to the year 1840. I had had a dwelling-house at Halesworth and Yarmouth. At Halesworth, Beccles, and Yarmouth I had houses of business. I resided at Yarmouth until 1838, and at Halesworth thereafter. In 1821 I began to malt there.

1210. Is it within your knowledge that any other merchants have been obliged to give up the corn trade at Southwold, in consequence of similar inconvenience?—Yes; one of the largest corn merchants, and of the longest standing, Mr. Jacob Mealing, left Southwold 30 or 40 years ago, and went to Norwich to carry on his trade; he and his son carried on the largest trade in the county of Norfolk; at one time they were the largest corn merchants in Norwich.

1211. From what port did they ship?—From Yarmouth. Mr. Jacob Mealing lived at Southwold, and carried on his trade at Southwold formerly, and he shipped at Southwold. William Blanden, wherryman, can give you much better information upon this, because he is an old man and knows the parties.

1212. Have you any further evidence that you wish to give?—We have a very small quantity of land-waters flowing down to Southwold, and therefore we ought to be supported with all the tidal water we can possibly get. By Act Anne 1, cap. 7, the Crown seems to have relinquished all Crown lands, and the country took them at that time; it was a bargain made between the Crown and the country upon Anne's Civil List being made, and in that Act there is a very particular provision respecting Crown lands.

1213. (Mr. *Hume.*) Do you consider that the lands which have been inclosed, and which were formerly overflowed, were Crown lands?—Most distinctly.

1214. You allude to that Act as giving to the public the right over all land within high water mark?—Wherever the ordinary spring tide flowed. The Act also provided for a rental of land in certain cases.

I think that the two lower reaches of the Halesworth Canal ought to be let out at every spring tide.

1215. Would the tide in that case flow up?—No.

1216. What advantage then would there be?—A quantity of scouring water would come down. My proposal to the Harbour Commissioners, when the price of iron was low and freights low three years ago, and all kinds of works so low, was that they could have made each of the creeks available as receptacles for water by constructing portable iron-framed sluice-gates across, that those creeks together with the two lower locks on Halesworth Canal, should be opened at such a period that the whole would come down simultaneously at the last quarter ebb upon the bar at Southwold.

Mr. Rendel, civil engineer, has given an opinion upon an abstract case which does not at all apply to Southwold. Lord Stradbroke produced this opinion to the Commissioners of the harbour at the annual meeting of the 20th July of last year, and mentioned it as an argument to show that the embankment had done good instead of harm to the navigation; and I believe Mr. Rendel now states that his opinion is by no means applicable to Southwold Harbour.

The limitation of the boundary of the harbour was taken out in the House of Lords. "Clause A" was added at the third reading of the bill in the House of Commons,—"that the limits of the said harbour of Southwold shall, for the purposes of this Act, be deemed and taken to extend to the distance of 100 yards above a certain quay called Walberswick Quay." A petition was sent up to the House of Lords by the Corporation of Southwold, praying "that such alteration be made in the said Bill as shall effectually prevent and restrain the Commissioners acting under the Blyth Navigation Act from claiming and imposing the tolls and duties mentioned in their Act, which may be shipped from and landed at the said quay called Blackshore Quay, by extending the limits of the said harbour to or beyond the said Blackshore Quay." The House of Lords took that money clause out of the Bill, and sent it back to the Commons for their approval. I then took steps in order to throw out the Bill in the House of Commons; but a promise was made me that four or five Commissioners might be elected at the first meeting, under section 6 of the Act, from merchants and others from the town of Halesworth; but they were not appointed, and three letters were written, which are printed at pp. 5 and 6 in the printed evidence laid on the table, addressed to Sir Thomas Gooch, Mr. Hume, and Lord Stradbroke.

1217. Sir Thomas Gooch was the member in charge of the Bill?—Yes: indeed I may say before the Committee of the House of Commons sat, and before the member for the county

Patrick Stead, Esq.

May 28, 1845.

took the chair, we agreed that no question should be gone into of past grievances; that we would endeavour to do everything possible to make it a good harbour in future, and with the understanding that there should be other periodically elected Commissioners introduced; but they delayed the Commissioners' clause until they had gone through all the Bill. I think there were six members sitting on the Committee, three of whom were elected by the Bill, and two of those three named in the Bill, so that the Committee elected themselves, which could not happen now under the present improved system of Committees in the House of Commons. That caused a great deal of opposition. Four or five petitions were presented against it, and not one in favour of the Bill, except the promoters' petition; a fifth petition against the Bill from growers of corn at Beccles came too late. The old Commissioners presented a petition for the new Bill, and they never got any one else to support it; so that we consider ourselves very hardly dealt with by that circumstance, particularly when I believe I am paying 300*l.* and 400*l.*, and sometimes 500*l.* a year in port dues, the whole revenue of the port being 1100*l.*; and it is a hardship which should not exist in the English constitution.

1218. (Mr. *Hume.*) You have paid that on the vessels employed by you?—I may fairly state above 300*l.* one year with another, during the existence of the Bill. Mr. Catt, of Brighton, is here, who will prove that he and his partners are large buyers of barley, and that they would not give me orders to ship it at Southwold, but only at Yarmouth. I gave up the barley trade and shipped malt, for it does not signify when malt comes up to London, because the brewers have from 20,000 to 30,000 quarters lying here in store. Another objection against this Bill, is that the qualification of Commissioners is too high, and in consequence they cannot get Commissioners; and further, I believe that the whole proceedings of the Commissioners are illegal, because some have been admitted without taking the oath, which, by the Act 10 Geo. IV., cap. 48, they are bound to take; the present Commissioners that are acting, I believe, have not all of them been sworn, and such appears to be liable to 50*l.* penalty; and the whole of their proceedings I therefore consider are illegal. I have consulted the collector of customs at Yarmouth, and others who are acquainted with the trade, and lawyers, and I believe I could run my ships up to Blythborough Bridge, and not pay anything, except trifling tonnage duties, about 2*d.* a ton to Southwold, if the ship goes beyond the limits of the port. I mention that to show the imperfections of the Bill.

1219. (*Chairman.*) Would you recommend that the limits of the port of Southwold should be altered?—Yes; they are now undefined, and we suffer in our own trade, from the limits not being properly defined. There is a coal trade carried on in Dunwich, within three miles of Southwold, and the coal merchants pay no dues, and compete with the Southwold and Halesworth merchants who pay dues, and thereby a great part of the revenue is lost. I believe on the Benacre side, to the north-east, there have been coals landed also.

1220. (Mr. *Hume.*) Do coal vessels go to those places to avoid the dues, or because they have not water to come into the harbour?—To avoid the dues.

1221. Could they come into the harbour?—Yes, they have come into the harbour, and taken shelter there, and then gone out and discharged. I believe that is the case to the best of my recollection, I should not like to state that positively as a fact.

1222. Have you complained of the embankments to any other authorities than the Commissioners and the House of Commons?—I complained to the House of Lords.

1223. Have you reported them to the Admiralty?—I have, and to the Woods and Forests, and Board of Trade.

1224. Have you taken every means in your power, to remedy, what you consider, an evil, by applying to such public bodies as you thought would take cognizance of those points?—Every constitutional means; but I have not used main force, as employed at Rye in 1830, whereby they gained their object.

1225. You complain of the expenses being high, have any books of account of the receipts and expenditure been given to you?—I have never been able to see the proper books which the Act requires, and I have never been able to check the accounts.

1226. What does the Act require?—Section 24 of the Act requires a book to be kept, "in which are to be entered true and regular accounts of all sums of money received, paid, laid out and expended, and the several matters and things, together with the quantities and prices thereof respectively," that clause was drawn up in my handwriting.

1227. Were those books to be accessible to any parties paying the rates or not?—Those books, upon the payment of a fee, are required to be shown, and copies to be given to any person in anywise interested.

1228. Have you, or any other person, applied to see those books?—I have applied to inspect the books, and to get copies continually since 1827, and I have not obtained any books such as the Act requires.

1229. Have the accounts been printed or published by the Commissioners in any of the newspapers?—I am not aware that they have.

1230. Have you, as a merchant, paying upwards of 300*l.* a-year towards those revenues, had access to books in order to ascertain whether the credits were proper and the expenditure regularly entered?—I have not, because those accounts are lumped; the sums are put in without quantity or price, which the Act requires.

1231. Where did you see those accounts?—They are here. I got them from the treasurer. I first went to the collector, Mr. Ellis, and then I went to the treasurer by his reference, and these are all the accounts that I have been able to obtain. (*The Witness laid on the table several annual accounts.*)

1232. (*Chairman.*) Did you ever apply to inspect the accounts which the Act required them to keep?—Repeatedly.

1233. Were you refused?—They told me that those were all the accounts they had.

1234. Was there a book kept?—They told me that such a book is not kept.

1235. You are aware of the 26th Section of the Act, which, in the first place, directs the Commissioners to keep a book, and in the next place directs "That it should be open for the inspection of the said Commissioners, or any creditor or creditors, or any person or persons in any way interested, upon the payment of one shilling?"—There are two clauses respecting accounts; one clause is a general clause, and the other clause is the clause I read.

1236. What are the clauses?—The first is the 4 Geo. IV. cap. 48, s. 14, that provides for the annual meeting of the Commissioners, and at that annual meeting they are to state the whole transactions "to the intent that the account so stated may be open to the general inspection and examination of all persons interested therein, who shall assemble themselves at such annual meeting." I once applied for admission, and there was some difficulty about it. I was admitted to the meeting as a matter of courtesy, I understood, and I therefore never went again. I would not attend by courtesy.

1237. (Mr. *Hume.*) Did you ever present yourself at any of those annual meetings, and were you refused?—I presented myself in the year 1840, and wrote a respectful letter asking to be admitted, and I was admitted then, but I understood by the address that I got, it was by courtesy, as it would be inconvenient to let many people come.

1238. You did not apply in any subsequent year to be admitted?—No, I did not, because I thought it was not the proper way to go.

1239. (*Chairman.*) Did you consider yourself entitled under the Act to attend?—I did, but the only way, and that is the hardship of the case, would have been to go to law.

1240. (Mr. *Hume.*) Have you any observations to make upon those accounts which you obtained from the treasurer?—The following is the account of 1843; the first charge is "for labour, &c. as per surveyor's book, 500*l.*"

AN ABSTRACT of the Account of Mr. JOSEPH BERRY EDWARDS, the Treasurer to the Commissioners of SOUTHWOLD HARBOUR, for the year ending 24th June, 1843, audited quarterly by a Committee appointed for such purpose.

RECEIPTS.

		£.	s.	d.
1842–3.	Dues on 10,636 tons 9½ cwt. of coals at 1*s.* 2*d.*	620	9	8
	Do. on 19,184½ qrs. of corn at 2*d.*	159	17	5
	Do. on goods, &c.	117	6	6
	Do. on 1846 tons of ballast	68	19	6
	Tonnage dues	1	11	10
		968	4	11
	Blyth Commissioners, proportion of			
1843,	survey	87	9	8
June 24,	Balance due to treasurer	90	17	6
		£1146	12	1

EXPENDITURE.

1842		£.	s.	d.
June 24,	Balance due to Treasurer	149	19	0
1842–3,	For iron and blacksmith's work, &c.	24	16	5
	Labour, &c., as per surveyor's book	500	0	0
	Interest on money borrowed	53	6	5
	Salaries and law expenses	178	14	7
	Timber, &c.	2	10	0
	Rope, yarn, oil, pitch, &c.	11	0	4
	Rent of office	10	0	0
	Stamps, printing, and advertisements	8	19	0
	Miscellaneous	7	6	4
	—Walker, Esq., on account of survey	200	0	0
		£1146	12	1

The foregoing account was submitted to the Commissioners, assembled at their Annual Meeting, at the Old Swan Inn, Southwold, the 15th day of July, 1843.

COUNTERSIGNED. HARRY WHITE, Clerk.

SIGNED. STRADBROKE, Chairman.

1241. Did you ever apply to see the surveyor's book?—I applied to see the book that is ordered to be kept by the Act, and the only book I could see was, I believe, a transcript of this account. I also applied to see the minute book, that I might prepare myself for attending the Tidal Harbour Commission, and Mr. Ellis said that he could not show it me.

1242. At what time did you apply?—About a month or six weeks ago.

1243. In writing, or personally?—Personally; I think I am entitled to see every minute to know how my money is expended.

1244. Is that printed abstract which you have produced all that you have ever seen connected with the accounts of that year?—It is, except the book of which I believe this is a copy, so far as my remembrance goes.

1245. Do you know whether any other merchants have seen it?—I cannot answer that, but if you will allow me to show the insignificance of the timber, which is a material charge, the timber is only 2*l.* 10*s.*; Mr. Walker's survey costs somewhere about 500*l.*, and there are 200*l.* here paid; the next large sum is "Salaries and Law Expences, 178*l.* 14*s.* 7*d.*," and "Rent of Office, 10*l.*" Those I consider excessive, and far beyond anything we know of at any other port along the coast.—(*See Appendix* for Abstract of 1842, which contains the cost for timber used in 1843.)

1246. Is there any provision for auditors being appointed?—They are appointed by the Commissioners themselves.

1247. Have the accounts of which you have an abstract in your hand ever been discussed or considered at any public meeting of the Commissioners held under the Act?—I am not aware that they have been discussed. Mr. Ellis will answer that; the meeting is held with closed doors, and nobody gets in but themselves.

1248. (*Chairman.*) Did you ever apply for permission to take copies or extracts from the book or books kept by the Commissioners?—I have, but the book does not exist; I asked only six weeks ago to see it.

1249. Do you mean that they keep no books?—I do not know what books they keep; they know that themselves, but they said they could not show me such a book, nor any other than that they had shown.—(*See Appendix*, p. 167—Return of Books kept.)

1250. You described the book in the terms of the Act?—I think I took the Act in my hand.

Patrick Stead, Esq.

May 28, 1845.

1251. (Mr. *Hume.*) You have stated that whilst in the Tay dredging costs only 2¼*d.* a ton, at Southwold it has cost nearly a shilling, including all expenses?—Yes.

1252. How do you come to that conclusion?—In the year 1840, from a conversation which occurred at the Commissioners' table at the annual meeting, where I was admitted by courtesy, I gathered enough to make out that it was nearly a shilling.

1253. Have you any other data upon which to form that opinion?—No.

1254. You have stated that the harbour of Southwold has been injured in the trade in corn?—Yes.

1255. Has it been injured, also, in the trade of coals?—Yes.

1256. Have any higher freights been taken for coals for Southwold, than for the adjoining port?—Yes.

1257. What do you pay?—We pay frequently 1*s.* to 2*s.* a ton more than Yarmouth, on account of the state of the harbour; sometimes we can freight ships for the same money, and at other times, when the trade is brisk, we cannot. At Southwold, the harbour dues are 1*s.* 2*d.* per ton on coals; at Yarmouth, 6*d.* per ton: on corn, 2*d.* per quarter; at Yarmouth, 1*d.* per quarter. The freight on malt from Southwold to London is 13*s.* per last; from Yarmouth to London, it is 10*s.* per last.

1258. What proof have you that that takes place?—When they have been paying a certain freight at Yarmouth for coals, we have paid more in Southwold, generally, but not always.

1259. You say Mr. Catt is a brewer, and can corroborate that statement of yours as to the injury which the harbour has gradually received?—Yes, and he can state the injury that was done to certain cargoes which were shipped for him.

1260. (*Capt. Washington.*) You have stated in your evidence that a large surface of land has been embanked which does not appear in Mr. Walker's, or any other survey; will you point out on the map where the spot is?—It lies to the westward of Wolsey Bridge.

1261. What is the extent of it?—I cannot say the number of acres, it may be from 200 to 400 acres.

1262. When was that embanked?—There is a traditional story that it must have been embanked in Cardinal Wolsey's time.

1263. Have you reason to believe that that marsh is below the present surface of the river at spring tides?—According to my judgment it is.

1264. (Mr. *Hume.*) Have the Commissioners of either navigation ordered any inclosures that have been made to be removed?—There has been no inclosure of this marsh land ever ordered to be removed, or ever attempted to be removed, by order of the Commissioners, so far as I know.

1265. Has any other impediment been ordered to be removed by the Commissioners?—The only case I recollect is contained in the following minute, which I request permission to hand in:—

"At a meeting of the Commissioners of the River Blyth, held at the White Hart Inn, Blythburgh, on Tuesday, 17th July, 1838, (amongst others,) the following minute was passed, viz.—

"No. 6.—'The attention of the meeting was called to the encroachments Mr. Stead appears to have made [by the side of the river] in marking his boundary round his new malt offices, whereupon it was resolved that such encroachments be removed under the direction of the Committee.'

"(Signed) STRADBROKE.
"(Signed) HARRY WHITE."

1266. Is there anything besides that which has been ordered to be removed?—To the best of my knowledge nothing besides; but there has been some dredging of the river and cuts made by the River Commissioners up above Blythbro' Bridge.

1267. *Chairman.* Are you aware that an examination of the Port of Southwold and the River Blyth has been lately made by the order of the Board of Admiralty?—I am; I had a letter from the Admiralty, informing me that they would investigate the statements contained in my three letters of the 24th April, 8th May, and 28th June, relative to Southwold Harbour, and Captain Washington came down in consequence of these letters; the moment he arrived he applied to the mayor of the town, and he went immediately to the Town Hall; he said, "We must have this inquiry public, and every person is at liberty to come to it;" and he invited whatever evidence any party might have to bring forward relative to the subject of the former and present state of the river, the harbour, and the bar.

1268. (Mr. *Hume.*) Were you present?—I was.

1269. Did that meeting of the inhabitants take place?—It did.

1270. Were statements made in your presence by the inhabitants to Captain Washington?—There were.

1271. Have you seen the report?—I have.

[*The Witness withdrew.*]

William Catt, Esq.

William Catt, Esq., of Brighton, sworn and examined.

1272. (*Chairman.*) What is your profession and place of residence?—I am now out of business; I reside at 80, West-street, Brighton. For several years previous to 1844, I was the acting partner in the house of Vallance, Catt, and Company, of Brighton, brewers, maltsters, and ship-owners.

1273. Did you ever send any ships to Southwold?—We did not send ships to Southwold, but we were in the practice of having barley shipped from there for several years up to about the year 1838.

William Catt, Esq.
May 28, 1845.

1274. Have you suffered any loss in so trading which you have attributed to the state of Southwold Harbour or Bar?—Yes, I have. At the end of the year 1837, we ordered a cargo of barley from Mr. Stead; he shipped it in a vessel called "The Brother's Friend." On the 1st of January, 1838, the bill of lading and the invoice was forwarded to us. We heard nothing of the sailing of the vessel, and on two or three occasions, we wrote to urge Mr. Stead to prevail on the captain to proceed to sea. On the 12th of March, 1838, we received intelligence that the "Brother's Friend" had taken damage in proceeding to sea. I, at once, by permission of the under writers, or at their request more properly, proceeded to Southwold, and there I found that the "Brother's Friend" had got upon the bar and had stranded; the agent there had commenced to discharge her, and on taking the cargo out in lighters, they got the vessel back again into the harbour. She was then discharged, and after the lapse of some time the cargo was re-shipped, and we received it at the end of May. Perhaps I should say that the malting season terminates generally at the end of April, and the length of time that this vessel was detained at Southwold, and the unfortunate circumstance, determined us to have no more transactions at Southwold. We wrote a letter to Mr. Stead, to the effect, that although we had the highest respect for him and his dealings, yet from the unfortunate detention of vessels, owing to the bad state of Southwold Bar, we could not have any barley from him, and from that period till I retired from business in September, 1843, we had no connection whatever with Southwold; although, the following malting season we imported nearly 10,000 quarters of barley, principally from Norfolk.

William Blanden, sworn and examined.

William Blanden

1275. (*Chairman.*) Where do you live?—I live at Halesworth, in Suffolk, and go from Halesworth to Southwold in my wherry.

1276. How many years have you done so?—Sixty-four; going backwards and forwards.

1277. How old are you?—Seventy-six.

1278. What is your opinion of the state of Southwold Harbour now, as compared with what it was when you were a young man?—I think the reason why the harbour is so bad is their stopping so much back-water; there were 500 or 600 acres of channel which the water used to cover, and now they have stopped it all up—sea-walled it all in.

1279. What embankment do you refer to?—There are some as high as five or six miles, and some are not above two miles up the river.

1280. How many embankments have you known made in your time?—I have known them embank 500 acres; there was not any embankments when I first went upon the river. I have gone over the marsh, now embanked, in my wherry.

1281. Tell us the marsh which you know to have been embanked in your time?—Bulchamp Marsh, that is above Blythborough Bridge.

1282. Are there any others?—Blythborough and Bulchamp Saltings.

1283. (*Capt. Washington.*) Are you sure that you remember the embankment being made at Bulchamp?—Yes, I am certain of it.

1284. (*Chairman.*) Is the current of the river less rapid now than it was when you were a young man?—A great deal; when there was a good deal of water, going back on the ebb tide, there used to be a great current run out; there were great creeks half as big as the river. I have been up many times in my wherry, and the current used to be a wonderful deal stronger, and the harbour a good deal better, than it is now.

1285. Are those creeks stopped up now?—Yes; they stopped them up when they made the embankments.

1286. Were you a pilot into Southwold Harbour?—No, never. I have gone up and down the river from Halesworth to Southwold for 64 years.

1287. But not going out to sea?—Sometimes I have gone to sea to lighten a vessel in.

1288. Do you remember larger vessels coming into Southwold than can get in now?—I have known vessels of nine feet and nine feet and a-half come in, and I have known them come in at half-flood; and now they can hardly come in at high water. There was a ship of Mr. Stead's, the other day, lay there two tides; she drew nine feet of water, and the tides were good springs too.

1289. (Mr. *Hume.*) But has anything particular happened at the mouth of the harbour from the rise of the bar?—No, there was never back-water enough to scour it out; it wants a good deal of back-water to scour it out at low water.

1290. Formerly, where did the vessels load?—At Reydon Quay.

1291. How many miles is that above the mouth of the harbour?—Not above one mile and a quarter.

1292. Can any vessels come there now?—Yes, we have vessels there now.

1293. But not drawing the same depth of water?—Yes, they will draw the same depth of water in going up there; the bar is the difficulty.

1294. How high does the tide flow up the Blyth River?—We reckon it to be about eight or nine miles.

1295. Have any locks or impediments in your time been thrown across to stop the flow of the tide?—No; we have the Bulchamp and Blyford Locks, after passing Bulchamp House.

1296. Does the tide flow above Bulchamp Lock?—No.

1297. If the lock was removed, would the tide flow above that?—No.

1298. Do you mean that the tide flows up by the old channel, although it is stopped from the new canal at the Bulchamp Lock?—Yes; at the Bulchamp Lock it is stopped.

William Blanden.

May 28, 1845.

1299. Are we to understand you to say that, in your recollection, the wherries and craft used to sail over the spots that are now enclosed as marsh land?—I have known one marsh that used to be under water at Bulchamp House 2 feet. I have known the craft come there; but they cannot get under the foot of the bridge.

1300. Is Blythborough Bridge any impediment to your going up and down the river?—It is; it is too low; the craft cannot get under it.

1301. At half tide can they get up?—Yes, at half tide up to the staunch; but sometimes they lie there for a day; they cannot get in, because there is no flow of water up the canal. There is not the flow of water now that there used to be.

1302. Did you know a vessel called the "Old Drop" within the harbour?—Yes.

1303. When was that built, and for what purpose?—It was built for the purpose of lightering the ships out and in.

1304. Is that used now?—No; she is broken up.

1305. When was she broken up?—I do not know; it was there when Lieut. Ellis first came as harbour surveyor.

1306. Was the "Old Drop" built in order to facilitate the lightering of vessels?—She used to go out to lighter vessels when they came up; but it is some years since she was used. I do not suppose that she has gone out for 20 years. When the harbour got bad from marshes having been embanked, and when the larger ships could not get in; but when the south pier was carried out, the harbour improved, and the "Old Drop" was not then required, but was used as a "Dideler" [dredger.]

1307. If you had a similar vessel now, would vessels be able to pass the bar as they did formerly?—If it were to go and take the cargo out they might come in; but they cannot without. Since those banks have been made this "Old Drop" came on the river.

1308. Is it your opinion that the enclosing of those marshes has injured your harbour?—That is my opinion; that is what has done it.

1309. (*Capt. Washington.*) Has not the lower part of the river in the Harbour of Southwold been much improved by dredging and straightening by the present harbour surveyor since the year 1830?—Yes, it has.

1310. When was Blythborough Bridge built?—I do not know.

1311. Was there more or less detention of wherries passing up and down the river formerly than there is now?—There was less detention than there is now.

[*The Witness withdrew.*]

Lieut. *F. W. Ellis*, R.N.

Lieut. Francis Wilson Ellis, R.N., sworn and examined.

1312. (*Chairman.*) You have heard the evidence given by Mr. Stead, of Halesworth?—I have.

1313. Will you be so good as to make any observations which you wish to make upon it?—If you will permit me, I will first go into the state of the harbour formerly as compared with what it is now, and show by documentary evidence that it was as bad centuries ago, and as much complained of, as at the present moment. The first authority I will quote from is Gardner's History of Dunwich and Southwold. At page 40 it is thus written:—"Notwithstanding, on the 14th day of January, 1328, the harbour was utterly choked up by the north-east and east-north-east winds, and for the recovery thereof all means proved ineffectual. In a short time after, by pressure of the great quantity of water pent up by the stoppage of the old haven's mouth, a new one broke out near two miles further northwards, which was likewise stopped about the beginning of the reign of King Henry the Fourth. Another was cut that, having on the south-east point thereof a strong bank of ooze, continued to the year 1464; but then this bank being washed away, the mouth was often altering. It is noted that although the north-east winds are wonted to turn the shingle upon the mouths of their havens from time to time, as doth daily appear, yet this last haven was fortified at the south-east point with such a bank of ooze as did turn back the said shingle again at the stay of such rages, as appeared divers times since the same haven was opened. A fourth, called Hummerston's Cut, was dug out near the last-mentioned; but this was often choked by means of a sand lying north-east near the mouth thereof, and very noxious to ships sailing in or out." * * "This haven being destitute of some means to secure the mouth thereof, was often stopped, and continued almost useless from the year 1614 to the year 1618, whereupon the bailiffs of Southwold sued the men of Walberswick concerning the haven and flats; from which time it hath been subject (by the violence of the out winds) to alterations."

This next paragraph refers to the year 1609. This is collected from the Harleian Miscellany; it is taken out of Wake's History of Southwold:—"This town of Southwold, of a sea-coast town, is the most beneficial unto his Majesty of all the towns in England, by reason all their trade is unto Iceland for lings, and his Majesty's serjeant-eater hath yearly gratis out of every ship and bark 100 of the choicest and fairest lings, which are worth more than ten pounds the hundred, and they call them composition fish. But these men of this place are greatly hindered, and in a manner undone, by reason their haven is so bad and in a manner often stopped up with beach and shingle stone that the wind and the tide and the sea do beat thither, so that many tides in the season, when they be ready to go to sea, they cannot get out when time is to go to sea, neither can they get in when they return from sea, but oftentimes do cast away their goods and themselves. This haven, if that it had but a south pier built of timber, would be a far better haven than Yarmouth haven, with one quarter of the cost that hath been bestowed on Yarmouth haven. They are now suitors unto his Majesty. God grant they may speed, for it is pitiful the trouble and damage that all the men of these towns do daily sustain by their naughty harbour."

Lieut. *F. W. Ellis*, R.N.

May 28, 1845.

I now come to June, 1747, and I produce the Minute Book of the Commissioners from the time they obtained their first Act of Parliament. I find this Minute:—"That it appears to us that the reason why the haven hath been stopped up is more for want of a good foundation under the old piers." And then, on the 5th day of July, 1748, "We do hereby agree that, if the said port or haven shall be choked or stopped by sands, or otherwise, the present Bailiffs, Master William Lenny, and three of the Commissioners named in the said Act, or any two of them, shall have power and authority to cleanse or open the said haven, and that Mr. John Smith, collector of the said duties, shall pay for the same." In Magg's Hand Book of the Port of Southwold I find, in page 9, "It has been already observed that, about 1618, the Bailiffs of Southwold assumed the superintendence of the haven, and it is beyond a question that, after the lapse of a very few years, they adopted it as their own; the Corporation being, for the most part, at the expense of maintaining it. The Corporation, however, are possessed of no accounts previous to 1661, and it is not until 1680 that the accounts contain anything specific as to the charges of the haven. From that year, however, it appears to have been a constant annual, but not great charge; but, in 1714, the charge of 'digging and making a new haven' was 37*l.* 10*s.* 11¼*d.*, at which time it appears that the annual income of the Corporation did not amount to 100*l.* Therefore, in 1723, when it became expedient 'to stop the haven, and to make a new one,' a deputation was appointed, at an assembly of the Corporation held on 21st of February, to collect 'aid from the gentlemen in the country.'" At the period we are speaking of, "the haven was fixed to no certain spot, but was occasionally to be found opening on various points of the compass, from the north-east to the south-west, under the control, as it would appear, of the wind; as, when the wind was sufficiently strong from the north-east to raise a sea, the channel from the river opened into the south-west, and, when the wind from the south-west was strong enough to raise a sea from that quarter, the channel opened into the north-east; when the wind was north-west, with a smooth sea, it opened into the south-east. In these changes the channel sometimes opened as much as 400 yards to the north-east of the present north pier, running inland, not far from the present road leading to the present haven; and, at other times, the channel ran to the southward as far as the post called Sir Charles's post, perhaps about 400 yards south-west of the present south pier." This shows how the bar is formed. It is identical with the state of the bar at the present time.

1314. (Mr. *Hume.*) You have read two minutes of 1747 and 1748, in which it appears that the Commissioners of that time authorised the Committee under whose direction the harbour was, to cleanse it out; are there in that minute book any further minutes respecting the state of the harbour?—There are a great many minutes respecting the state of the harbour, the works to be done, the extension of the piers, and various matters of that kind, but I do not, up to the period when I went to Southwold, find any particular entries as to the date at which the harbour was choked up, but I find in Magg's Hand-book, that between 1805 and 1818 it was dug out 13 times.

1315. (*Capt. Washington.*) But will not the accounts show it?—Yes, but I have not the accounts, they are in another department, the Treasurer's.

1316. (Mr. *Hume.*) Do you keep the minute-book?—No. I am not clerk of the Trustees. I am harbour surveyor and harbour collector.

1317. What further minutes are there in that book respecting the harbour, and are there any sanctioning any embankments on the sides of the river?—There are two minute-books down to the present time, I have seen no reference whatever to embankments in the minute-books.

1318. Are there entries of complaints against embankments?—None, that I am aware of.

1319. Then in the books you have no proofs or traces as regards either embankments or complaints against embankments?—No, the complaints that have been made are entered in this book, but there are no complaints of embankments till within about the last 15 years, till Mr. Stead came to Southwold. The embankments were most of them made before there was any Harbour Act.

1320. (*Chairman.*) Were you the harbour surveyor in 1830?—I was.

1321. What, in your opinion, was the state of the harbour in 1830?—The state of the harbour has been very much improved since 1830; in 1829, the year that I was appointed, when I went to Southwold the harbour was in a very bad state, arising from the banks in the interior of the harbour.

1322. Explain what those banks were?—The Bellar Shoal ran across the lower part of the harbour. There was insufficient water for the vessels to go up or down the river, in consequence of the shoals in the main channel; the Bellar Shoal was cut through by a steam dredger in 1833, and the shoals were cleared away as far up as they existed, which was nearly to Black Shore Quay.

1323. What distance is that?—Nearly a mile, the consequence was that the harbour which was frequently blocked up previously, went ten years without closing up; the closing up had been more frequent in previous years.

1324. (Mr. *Hume.*) In what way did the clearing of the shoals tend to keep the bar open?—In consequence of the unopposed force of the water coming down the river upon the bar, and not being obstructed by the Bellar and other shoals.

1325. (*Chairman.*) From 1830 to 1840 the harbour was not blocked up?—To 1839, I should say nine years.

1326. (Mr. *Hume.*) What other works have been carried on by the Commissioners?—The piers have been very much repaired, part of them rebuilt. The jetty which existed at the lower part of the harbour has been removed, and a skeleton quay constructed near Blackshore. Vessels now, instead of loading or unloading at the old jetty, go to Blackshore and Reydon Quays, which they were unable to do before.

Lieut. *F. W. Ellis*, R.N.

May 28, 1845.

1327. Is it your opinion that the deepening of the river by dredging, as stated by you, admitted a greater flow of tide, and by its effect tended to sweep the bar?—I do not know that it admitted a greater flow, but I think it has that tendency. It admitted a larger body of water.

1328. Do you mean that the fresh coming with greater force, and more directly upon the shingle which formed the bar, tended to keep it open?—Yes.

1329. Can you remove any impediments now existing to the flow of the tide up?—There are no impediments in the lower part of the harbour, but if the channel of the navigation above was dredged and cleaned out, a much greater body of water would be admitted into the river, which would very materially and essentially improve the bar.

1330. Are you aware that on the banks of that river, enclosures of land formerly covered by the tidal water have been made?—Of my own knowledge I know nothing, but from general statements, and the reports of Mr. Walker and Mr. Rennie, I presume that to be so.

1331. Do not those enclosures interrupt the flow of the tide upwards, in the same manner as the banks which you have removed from the lower harbour did?—I apprehend not.

1332. Do you say that the enclosures of those lands on both sides of the river, have not been an impediment to the flow of the tide?—Certainly not, in my opinion.

1333. It has been stated to the Board, that some of the marsh lands were formerly covered with water approaching to three feet deep, and that they are now dry, is the opinion you have given consistent with that fact?—I will endeavour to explain it. By confining the water in the channel of the navigation, we obtain a greater depth than if it was allowed to expand itself over a larger area.

1334. If it was allowed to expand itself over a larger area, so as to admit of a larger quantity, would not the power of that efflux be far stronger than it is now, by being kept to the channel?—I do not think that there would be a larger body of water come in if the embankments were removed; and I will assign as a reason for my opinion, if you will allow me to refer to it, Mr. Langley Edward's Report, who surveyed the river in the year 1757. You will find that in that year he says, "At Blythborough Bridge the tide flows into the said river from Southwold Haven through the bridge, and waxes five feet there at common spring tides." In Mr. Rennie's Report he also says, "The average rise of the water there," that is at Blythborough Bridge, "is about five feet, and the tides used to cover them about six inches." Mr. Walker, in his Report of 1841 (*see App.* p. 170), gives a rise of six feet and a-half at the same spot. Consequently it appears from those documents, if they are any authority, that at the present day there is a foot and a-half more rise of water there than there was formerly.

1335. Since Mr. Edwards's survey have you not dredged the river and removed the shoals?—Yes, in the harbour.

1336. Then by that means you have admitted a larger quantity of water?—I suppose so.

1337. That will, in part, account for the increase?—No doubt it has a tendency to improve the navigation.

1338. If other impediments were in the same way removed would not that also further improve the navigation?—Certainly.

1339. (Mr. *Rice.*) The impediment is in the bed of the river?—Yes.

1340. Therefore that is a facility to the flow of the tide, it has not increased the reservoir?—If you get six feet and a half instead of five feet you increase the reservoir; I mean to say that the water being shut out from those lands, and confined in the channel of the river, tends to increase its height, and I am fortified in that opinion by Mr. Rendel. (*See App.* p. 175.) I will state further, that there are two creeks, Buss Creek and Wolsey Creek, mudded up, and which are not at all affected by the embankments that have taken place above.

1341. (Mr. *Hume.*) In as far as the tide cannot flow up those creeks now, the quantity of water on the ebb must be diminished?—Yes, and on the flood also.

1342. Then, would it not tend to improve the harbour if you had those creeks deepened as well as the parts that you have now deepened?—Unquestionably; but I instanced them to show that the embankments are not the cause of the river silting up as much as it has done. Buss Creek I find, in Gardner, was formerly large enough to contain 150 fishing vessels.

1343. You are of opinion that the improvement of Southwold Harbour would be promoted by deepening and removing the silt from all those tributary channels and creeks?—Yes, precisely so.

1344. Is it your opinion that you would facilitate the improvement by admitting in every possible way the ready influx of the tide?—Unquestionably; we should obtain in consequence a greater momentum of water, which is what we want; we have an insufficient supply of fresh water and that is one reason why those creeks have been choked up. The Buss Creek is now hardly deep enough to float a boat, and not being affected by the embankments, I draw the conclusion that there is a tendency for the navigation to choke up for want of some artificial aid in the interior of the navigation.

1345. To what do you attribute the difficulty which took place at the bar in 1839?—Entirely to the east and north-east winds.

1346. There is not natural water enough to sweep away the banks that are formed by the easterly gales?—The harbour blocks up during the east and north-east winds from the great quantity of shingle which comes along the coast, which meets with an impediment at the piers, and there forms itself into a bank; it comes in upon the flood tide, and before high water, closes the channel to such a narrow compass that when the ebb comes it has not power to keep it open.

1347. (*Capt. Beaufort.*) Which way does this shingle come?—From the northward.

1348. (Mr. *Rice.*) You stated that you were fortified in the opinion which you have now expressed by Mr. Rendel's opinion, when, and in what way, was Mr. Rendel's opinion expressed?—In answer to the queries of the Earl of Stradbroke. I have many sketches in these

books which I now produce of the position of the harbour's mouth, and which show how the bar has been affected by the different winds.

1349. (*Chairman.*) By the Act of 1830, Commissioners were appointed for the improvement of the harbour of Southwold?—Yes.

1350. Mr. Stead complains that he has not had access, agreeably to the terms of the Act, to the accounts, and that he has not seen more than a general abstract, not including any items; what observations have you to make upon that?—I have to state in reply that the Treasurer is the appointed officer for keeping the accounts, in accordance with the 26th section of the Act, and I consider that the accounts of Southwold Harbour are kept in a perfectly regular and proper manner. The Commissioners have a quarterly audit of the accounts, in which every item is sifted and every expenditure looked into, and these books are signed quarterly by the managing Committee. According to the Act of Parliament, an abstract of the year's accounts is made up at the annual meeting, and published for general information. I now produce and put in the printed Annual Abstract of the accounts as required by the Act of Parliament from the year 1836 down to the present time.

1351. Those abstracts are taken from the book kept in pursuance of the 26th section of the Act?—They are made in pursuance of the 14th section.

1352. Are there books of account kept in compliance with the 26th section?—That book is kept by the Treasurer, then there are supplementary accounts which I render; there is the collector's account for the collection of the revenues, and the surveyor's account which includes the weekly labour and the dredging; the surveyor's book is kept as a receipt and expenditure book. Mr. Stead has never applied to me for an inspection of it or of the collector's book. About a month ago, when he was coming to London, he applied to me for some documents which I did not feel at liberty to furnish him with, and also for an inspection of the minute book.

1353. Were there not some petitions which he had presented to the Commissioners, or some letters which he applied for?—Yes; and also the minute book, which he had no claim to see; and when I declined to furnish him with that inspection, he then asked for the accounts. I asked him what accounts he wanted, and he said, the accounts of the general expenditure; and I referred him to the Treasurer's book which is kept under the 26th section of the Act, and which is open to the inspection of all the payers of dues.

1354. All this you state from your own knowledge?—I do.

1355. Is the work performed at Southwold publicly contracted for?—The materials are advertised for by contract when required for repairs of any extent; when there is any new pier work to the extent of 40 or 50 feet, the materials are advertised for by public contract.

1356. How is the dredging done?—The first dredging was performed by the Commissioners' own steam dredger, but they advertised for parties to contract for the work, that is, supply the wherries and labour; that contract was taken at $4\frac{1}{4}d.$ per ton by the late Mr. Godfrey Goddard, that was in 1833: that dredger worked for three years at that contract price, when the harbour being completely opened out, and a debt having been contracted by the undertaking, which was a very gigantic one for a harbour with so small a revenue, the dredger was sold, and the money appropriated to the liquidation of the debt. In 1839, when the harbour, by a long succession of north-east winds, became bad again, the Lowestoff dredger was hired, and then the contract for wherries, and the work was taken by Mr. Clarke, of Yarmouth, at $5\frac{3}{4}d.$ per ton. That was done by public contract. I have the advertisements here, and I should wish to produce them, because it has been asserted that the contract was made without due advertisements.

1357. Where was the contract advertised?—In three county papers, circulated in Norfolk and Suffolk. The contract was taken by Mr. Clarke, of Yarmouth, a gentleman who at the same time was under a contract at Yarmouth for the same purpose; his contract there was $5\frac{1}{2}d.$ per ton, and his contract at Southwold was $5\frac{3}{4}d.$ per ton. Mr. Stead has said that at the Tay a contract was done at $2\frac{1}{4}d.$ per ton, and might have been done as cheaply at Southwold, and therefore I wish to show that in a port near Southwold, viz., at Yarmouth, the contract was only a farthing a ton different; and when the contract was made Mr. Clarke stated to the Commissioners that his contract at Southwold was much less advantageous to him than his contract at Yarmouth for various reasons, one of which was, that he had to send wherries from Yarmouth at great risk and expense. I will, with the permission of this Commission, put in the three advertisements for the contract which were published in the county papers. The contract at the Tay was for labour only, exclusive of wherries.

1358. By whom are the auditors chosen?—By the Commissioners. There is a Committee of Commissioners appointed every year as a Committee of management, whose province it is to audit the accounts, and to look into every item of the expenditure.

1359. The Commissioners appoint the auditors?—Yes, from themselves.

1360. How many?—Seven.

1361. By the 6th section of the 11th of Geo. IV., the Commissioners of Southwold Harbour were empowered to elect five additional Commissioners, do you know whether any of these Commissioners were elected at the first meeting, or subsequently?—The Earl of Stradbroke is one of those six. Lord Huntingfield is another appointed under that section. Mr. Reynolds, of Halesworth, is a third, and there are others that have been appointed, (but whether under that section or not, I cannot say,) for other vacancies have been filled up; all the justices of the peace are also Commissioners of Southwold Harbour. There are now three Commissioners of Halesworth, the fourth, Mr. Ringwood, is lately deceased; those three, and Mr. Lay, who lives in the neighbourhood, may be all considered as Commissioners from Halesworth, in the Southwold Commission; taking then the Halesworth quota at five, that town is more fully represented in the Commission than Southwold. The qualification tends to exclude merchants

Lieut. *F. W. Ellis*, R.N.

May 28, 1845.

and ship-owners, there are very few, scarcely any qualified in either place, but every nautical man qualified is in the Commission. Of the River Blyth Commissioners, there are about 50, there are no *ex-officio* Commissioners, and there is no qualification to exclude; they are a self-elected body, yet though they complain that they are not represented in the Southwold Commission, they have only one person from Southwold in the Blyth Commission, and that is myself. With regard to the blame, if any, that may be imputable with respect to the embankments, they are all, with very little exception, within the jurisdiction of the Commissioners of the River Blyth, and the River Commissioners do nothing beyond making the channel navigable for wherries, consequently it is insufficient to be of any palpable benefit to the harbour. I do not think that the Southwold Commissioners have any power with respect to those embankments. Blythborough Bridge, of which the River Commissioners so much complain, is out of the jurisdiction of the Southwold Commissioners. Mr. Stead complains also of the salaries being very excessive, and he makes a comparison with Yarmouth, where the salaries of the pier-master and collector alone amount to 500*l.* I will state what the salaries are. For my own services as the principal executive officer, in which I perform the duties of harbour surveyor (and that of engineer as far as I am able, for I built them a steam dredger without any assistance), collector of the harbour dues, harbour master, clerk to the committees, and general secretary when the aid of writing is required, pilot-master, and rendering my assistance in every possible way upon all occasions, I receive a salary of 100*l.* a year, with an allowance of 10*l.* for an office, for which I have furnished the Commissioners with one of the best rooms in my house, completely fitted up as a harbour office. The treasurer's salary is 35*l.* a year, the deputy harbour-master 10*l.* a year, and the clerk's salary 13*l.* a year, making 168*l.*; that is the total amount of the salaries. Mr. Stead's observation of the defect in the Act, that vessels land their coals at Dunwich and other places, is correct, and can only be remedied by a fresh Act. Dunwich is a small place, and coals are landed there, the object being as much to save the harbour dues, as to get their coals close at hand; they save four miles of land-carriage over a bad road by landing their coals at the beach.

1362. (*Capt. Beaufort.*) Are you perfectly satisfied that the inquiry that was made at the port of Southwold, by order of the Admiralty in last year was a full, public, and impartial one?—Certainly; I was present at it; there was some evidence, that of Fisk, a wherryman, taken at Blythborough Bridge, and James Sterry, Deputy Harbour Master, which has not appeared here to-day, and which would contradict the evidence given by William Blanden. (*See Appendix.*)

1363. (*Capt. Washington.*) Do you admit the accuracy of Mr. James Walker's survey of, and report on, the River Blyth and Southwold harbour, made in the year 1841, as to facts?—Yes.

1364. You are aware that from that survey and report it resulted that at ordinary spring tides 150,000,000 cubic feet of water have been excluded from the river?—Yes, but I must be allowed to qualify my first answer; I think that his calculation is fallacious; I do not believe it to be the fact that 150,000,000 cubic feet of water are excluded.

1365. If, in addition to the dredging, deepening, and straightening the harbour, carried on under your superintendence, the additional flow of water stated by Mr. Walker had been admitted, would it not in your opinion, as a sailor and experienced harbour surveyor, have been very beneficial to the harbour and bar?—I think that Mr. Walker is in error in assuming that such a body of water has been excluded by the embankments, because it appears by his own report that there has been a foot and a half additional depth gained in the channel of the river, since the last of the embankments have been formed; he makes the flow to be 6½ feet, whereas Mr. Edwards and Mr. Rennie make it only 5 feet. Those embanked lands would have silted up ere this, had they remained open.

1366. At what place is the rise of tide said to be 5 feet?—At Blythborough Bridge.

1367. Have you read Mr. Rennie's Report, dated the 6th of January, 1830?—I have.

1368. Does he not distinctly state, "Good springs rise at Southwold Harbour 6 feet 6 inches, and the tides at Blythborough rise nearly as much as they do at Southwold?"—Those are his words; but he says before that, that the rise is 5 feet. Mr. Langley Edwards, in 1757, also states the rise at common spring tides to be 5 feet at Blythborough.

1369. You have stated that the Harbour Commissioners have no right to object to impediments or embankments in the River Blyth beyond their limits, do you mean to assert, to put an extreme case, that the River Commissioners might place a lock across the river, without the limits of the Harbour Commissioners, and so cut off the whole of the water of the river?—I did not state that they had no right to object, I stated that I did not think they had any power to interfere; that is, to pull down the embankments, it being out of their jurisdiction.

1370. Is not the volume of fresh water brought down by the River Blyth utterly insignificant?—Yes, excepting in wet seasons, when the scour on the ebb is materially assisted by the freshes.

1371. In the minutes of a meeting of the Blyth Commissioners, on the 17th of July, 1838, the 6th paragraph says, "The attention of the meeting was called to the encroachment [in the river] which Mr. Stead appears to have made in making his boundary round his new malt-houses, whereupon it was resolved that such encroachments be removed under the direction of the Committee," are you aware of that order having been given?—No.

1372. You admit the authenticity of this copy of the report of the proceedings which I now show you?—Quite so.

1373. Then it appears that although unresisted embankments to the extent of 1500 acres had been made upon the river, still that meeting decided to pull down an encroachment perhaps not 20 yards in extent?—Yes.

1374. Thereby admitting that the whole of the other embankments were illegal, and that

they had power to order them to be removed?—Is there not some misapprehension? This is a document of the River Blyth Commissioners, and this embankment is at Halesworth; this never came before the Southwold Harbour Commissioners. They could have no jurisdiction nine miles up the river within the precincts of the River Blyth Commissioners.

1375. Is not the same person chairman of the Southwold Trust and the Halesworth and Blyth Trust?—I cannot say who is chairman of the River Commission; the chairmen are, I believe, elected on the day of meeting.

1376. Was not the same person chairman on that day who is usually the chairman of the Southwold Commissioners?—Yes.

1377. Is not the law for Southwold Harbour and the law for the River Blyth the same with respect to embankments, and also for all the rivers in the United Kingdom?—I should say that that is a question which hardly requires an answer from me. The law is the same throughout the United Kingdom of course; but as to the authorities which have been presented here by others, namely, the opinions of Judges, of Mr. Grose and Mr. Chitty, I think the cases are very wrongly stated, and I think that the cases quoted for the opinion of the Judges are not analogous.

1378. You are aware that I do not refer to any opinion of Judges, but to the Act of Parliament 46 Geo. III., c. 153?—I do not know of any Act which confers any power except that Act which passed in 1806; and I think that embankments in public rivers made subsequent to the passing of that Act, without the approbation of the Admiralty, are illegal. That is my individual opinion; but I think all other embankments have been sanctioned by time, and that it is now impossible that the possessors of them can be disturbed in their possession. I think some of the embankments on the sides of the river have been made for centuries, and that there is a prescriptive right to them. If you refer to the opinions of the Judges, I think you will find that prescriptive rights are excepted. I will state another circumstance: last Session a Bill was brought into Parliament called the Commons' Enclosure Bill, in which it was proposed to legalize all such embankments as had been made within 20 years. How then can any person come forward, as some have done in the present day, and talk of having grazing lands, which have been enclosed for centuries, restored?

1379. (*Capt. Beaufort.*) Have you considered what would be the best way of improving the harbour of Southwold?—I would follow out the improvements recommended by Mr. Walker, that is to widen and deepen the channel of the river, so as to make it navigable up to Bulchamp Lock, and to clear out the creeks by steam-dredging, by which means a great additional quantity of water would be brought in and out of the harbour, giving a greater momentum to the current, and thereby very much improve the bar. I think all extension of piers prejudicial, because Southwold Bar being a shifting bar you cannot throw out your piers to act upon a shifting bar as you would upon one which is more stationary.

The Southwold Harbour and the River Blyth Commissions should be merged into one Commission, and the limits of the port defined and made identical with the Customs' limits.

I would further suggest the constitution of a central Harbour Board in London, to have the supervision and control in the improvement and management of all the harbours in the United Kingdom, with Sub-Commissioners or local assistants of inspection, leaving to the local authorities the administration of local matters of detail; to have one General Harbour Act, so as to obtain more harmony of action, assimilating the constitution of the local Harbour Boards, the provisions and penalties, &c., as far as practicable, with a power vested in the Central Board to vary or alter according to circumstances; to have the regulation of pilots and pilotage; and to have annual returns made of revenue expenditure and all other matters and things relating to each harbour.

1380. If those means were adopted which you have been enumerating for the improvement of the harbour, what depth of water would you expect to get?—We have now in still weather, at high water, about 10 feet, and if those means were adopted, that depth would be greatly increased; it is hardly possible to say to what extent.

1381. At what rate of velocity do the spring tides enter your harbour?—They go out with greater velocity than they come in; our spring tides are about four knots an hour.

1382. (*Capt. Washington.*) Had not the Southwold Commissioners some plan for the improvement of the entrance from Mr. Calver, the master of the "Blazer"?—They had.

1383. And you approved of that plan?—Yes, upon general principles, it is the best that has been propounded; but Mr. Calver deprecates any extension of piers, and I think that the extension of sheet piling, such as he recommends, would have the evil effect of extended piers, unless a breakwater was constructed to the northward, to carry off the passing shingle into deep water. A copy of Mr. Calver's plan, with his report on the improvements of Southwold, is included in the returns now before this Commission.

1384. Is there any worm, such as the *teredo navalis*, in Southwold Harbour, which destroys timber?—Yes, a very powerful worm. I would make an observation with regard to the masters who gave their evidence before the River Blyth Commissioners; it is very conflicting. At the meeting of the Southwold Harbour Commissioners, when they received the evidence which the Commissioners of the River Blyth submitted to them, there was no attempt made to controvert what was submitted; the object was to receive all the evidence and suggestions that might be made for the improvement of the harbour; when they had so done, that evidence was submitted to Mr. Walker for his opinion, and upon that is founded the report of Mr. Walker. Some of these documents produced by Mr. Stead have never been before the Southwold Commissioners, and therefore, of course, they have not had an opportunity of answering them.

[*The Witness withdrew.*]

G. Stephenson, Esq.

May 28, 1845.

George Stephenson, Esq., Civil Engineer, sworn and examined.

1385. (*Chairman.*) You are engineer to the Whitehaven and Furness Junction Railroad?—I am.

1386. Will you state generally what is the line of that railroad?—The line goes along the coast from Whitehaven to St. Bees to Ravenglass, to Duddon Sands, and then across to Furness, forming a junction with the Furness and Piel Railway. The object is to get away the iron-stone; there is a large quantity of iron-stone worked in that neighbourhood and sent into various parts of England.

1387. Is it any part of that plan to cross Morecambe Bay?—No, not at present? we may have another project for crossing Morecambe Bay; there is no such plan in Parliament this year, but I dare say it may be next year.

1388. (Mr. *Godson.*) Would not this be a part of that railway?—It would.

1389. Is not the object of crossing the Duddon Sands and coming down to Ulverstone to form part of a railway to get into the Lancaster and Carlisle Railway?—It is; not only that, but there is a line to be brought before Parliament next Session to go into Yorkshire which will join at the same spot where we shall join the Lancaster and Carlisle Railway.

1390. At what place is that?—It is between Bolton and Milnthorpe; and then this other line will continue on by Skipton, and down to the eastern parts of Yorkshire.

1391. What length is the Furness and Piel Railway?—About six or seven miles.

1392. Is your object in crossing the Duddon Sands to join a new railway of only six or seven miles?—At present, it is, because that forms a communication to the Piel Harbour and from the Piel Harbour we expect to carry on the traffic to the Preston and Wyre Railway by steam boats. At present the vessels take up a good deal of iron at Piel, and we also mean to carry the iron round by Whitehaven, and thence down the Newcastle and Carlisle Railway to the iron works at Newcastle.

1393. But at present you do not purpose going further than the Furness and Piel Railway?—Certainly not.

1394. In what way do you mean to cross the Duddon Sands?—By an embankment.

1395. How long will that embankment be?—A mile and a quarter.

1396. How much of the navigable part of the Duddon water would you cut off?—I do not know the extent of it, the whole of the water above the embankment of course will be cut off. Probably about 5000 acres.

1397. How many miles is it from there to Broughton?—About four miles, but then we propose giving them a railway up to the same place instead of the navigation.

1398. Up to Broughton?—I do not know that we shall go up to Broughton, but we mean to make it as beneficial to that district as the navigation is at present. The railway does extend already some distance towards Broughton, we mean by continuing it further to give them the benefit of a railway not only to Piel but to Whitehaven. From Whitehaven, coals brought down to Broughton will be reduced one-half.

1399. How is the water of the river Duddon to get through?—I mean to make an outlet.

1400. (*Capt. Washington.*) Is that in the Bill?—No; we shall have to do it by private contract; we had it on our plan, but it was not given notice of. The way in which I mean to construct the embankment is this. I am quite aware that it is impossible to form an embankment in a place like this, if I were to make a common embankment. My reasons for saying it is impossible are these:—when the two embankments came near together, if I were to embank this in the common way, the current would be so strong that no material that I could put in there would stop, and it would be impossible to finish it. My plan is this: to go, as it were, by stealth; for instance, I would construct wooden bridges on piles to the height that the embankment is intended to be.

1401. How high above high-water mark?—Six feet. Then having constructed this wooden railway on piles, allowing the water to flow freely, as it has hitherto done, only obstructed by the piers, I fix a steam-engine on each bank of the river, and I draw the waggons across, to and fro, with a chain. Then when the material is dropped out, I keep it as nearly level as I possibly can, and shall keep a man to survey this every day, or the whole of the day, so as to give notice to those who have charge of the waggons where the lowest part is, that that may be kept up level with the other. I go on keeping it so till I bring it to the proper height. I allow the water to flow over. I am, in fact, merely making a mill dam. There can be no risk, providing they bring the material that shall not wash away. I shall bring craft, and pitch it in; then going on step by step, as I have stated, at last I prevent the tide from flowing over; then I carry it up to such a height that the waves will not affect the railway, and of course I finish. I do not believe that this water will stop up to the level of the embankment for many years. I think that in a great part of this new embankment it will ooze through; but, ultimately, I believe it will come quite level into the outlet, and another outlet will be made to carry off the land floods.

1402. (Mr. *Godson.*) In other words you mean a new channel for the river?—Yes.

1403. How deep is the sand upon which you are to throw in materials?—It has been bored, but I do not exactly recollect; it is not deep, I do not care what depth it is. I am confident that it would answer in the way I propose.

1404. What is to become of the bed of the river from the embankment up to the source?—It is to become land.

1405. Who claims it?—I believe the Crown claims a part, and Lord Lonsdale and Lord Burlington, and I believe the Duke of Buccleugh.

1406. Was there not a plan suggested some time ago for crossing Morecambe Bay?—Yes; that is a plan which I proposed some years ago; it was projected by some other person after me, Mr. Haigh, but his plan was very different from mine.

1407. But was not your plan to cross Morecambe Bay somewhere near Bolton, and then to go by Chapel Island, and to land by means of having a wooden railway above, and by dropping in stuff in the course of years to allow the sand to silt up against it, and by and by to make an embankment across the bay, taking care to lead the water of the river that runs into the bay in an artificial canal so as to come out nearer the sea into the bay again?—That I think was proposed by Mr. Haigh, that was not my plan. I do not think it could be done. In making out my Report, I stated to the Directors that though I believed it was practicable to embank in the way I have stated, it was too great a work for any Company to take up in my opinion without having Government assistance, and then the Directors published my report, but left that part out. My report was published with a view to raise money to do the work, but they left that out, and I then resigned my place, and they got Mr. Haigh.

1408. Would it not be useless to have a line to cross Duddon Sands, unless you had afterwards a line to cross Morecambe Bay?—No; it would not be so good a line to the public, without being carried forward over Morecambe Bay, but still it would be a line to Lancashire, by making use of steam-boats from Piel Harbour, going by the Preston and Wyre Railway.

1409. Is not then your object to get to the Preston and Wyre Railway?—Yes.

1410. Then one of your objects in crossing Duddon Sands is to get a communication to the Preston and Wyre Railway from Piel?—It is; I did not think that there was money to be got to carry the thing out when I recommended it to Lord Lonsdale and the Whitehaven people, therefore we stopped short after crossing the Duddon Sands. Before the Bill was granted for the greater work, I should like to accomplish this.

1411. But having accomplished this, you would make that a reason for asking for the next?—Certainly I would.

1412. (*Chairman.*) We have gathered from your previous answers, that it is intended to afford some communication to Broughton in the shape of a railway?—After hearing that there might be some complaint made, I stated that I thought we ought not to take any benefit from any district without giving them something as good.

1413. This is what is complained of from a party residing at Broughton Tower. "I beg leave to call the attention of the Lords Commissioners of the Admiralty to a Bill which is now before Parliament, for making a railway, to be called the Whitehaven and Furness Junction Railway, and which is intended in its course to cross the river Duddon, near the estuary thereof, (where it is of very considerable width) by means of a viaduct and extensive embankments, in order to join the Furness Railway, near Ireleth. The river Duddon is navigable to within two miles of this place, and affords the means of conveyance for coals and other seaborne goods, at a very moderate rate of carriage, to the market town of Broughton, and the surrounding district. I am advised by persons of competent knowledge on the subject, that the effect of the proposed embankments and viaduct will be either to totally destroy the navigation of the river by preventing the passing of vessels laden with coal and other produce, or at all events greatly to impede and injure such navigation, and as this is a point of the first importance to the town and neighbourhood of Broughton, in which I am deeply interested, I take the liberty of appealing to the Board of Admiralty on the subject, in the hope that their Lordships will not consider such a matter wholly unworthy of their attention. I am hardly qualified to say in what way the evil in question can be obviated, supposing the proposed line to be adopted, but it has been suggested to me, that a swing bridge of competent dimensions might be thrown over the river, which would prevent the stoppage of the navigation, though I cannot presume to say how far the proposed embankments might affect the channel of the river?"—I should not think of proposing a swing bridge; the current of the water would be so great, that I think it would be unwise for any engineer to attempt such a thing.

1414. (Mr. *Godson.*) You rely upon the silting up of the river by means of the materials that you would throw in?—Yes.

1415. (*Chairman.*) So far as the town of Broughton is concerned, you would be prepared to furnish them with good accommodation?—Yes, the Railway Company will be prepared to give them more benefit than they will take away from them.

1416. (*Capt. Beaufort.*) Could not you carry your railway up the right or west bank of the Duddon so as to cross from Shaw Point to Angerton?—It would carry the line so many miles round, that it ought not to be made at all. I would not make it.

1417. In what way would it carry it round; it would leave that line that is to join across the country to Leeds?—No, you could not cross that country; you could not get over the ground. There is no other way but to come to this place.

[*The Witness withdrew.*]

Adjourned till Friday next, at One o'clock.

Lord Advocate of Scotland.

May 30, 1845.

Friday, 30*th May*, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir G. Bremer, K.C.B.	Captain Beaufort, R.N.
Mr. Hume, M.P.	Mr. A. Chapman, M.P.
Mr. Godson, M.P.	Captain Washington, R.N.
Mr. Rice, M.P.	

Lord Advocate of Scotland called and examined.

1418. (*Chairman.*) You are Lord Advocate of Scotland?—Yes.

1419. Will you explain to the Commission what is the present state of the suit now pending between the Trustees of Montrose Harbour and Sir James Carnegie, Bart., on account of certain alleged encroachments?—I examined the papers in the case, and the view I take of it is this:—The proceeding was between Sir James Carnegie and the Montrose Harbour Trustees. Sir James Carnegie had effected certain operations which had not been objected to; then he effected some further operations, which were objected to on the part of the Montrose Harbour Trustees, and they applied to the Court for a suspension and interdict, as we call it, which is similar to an injunction in England, to stop those proceedings. The Court granted the interdict or injunction in the mean time. That is a usual thing upon the first statement of the matter, until there is an opportunity of putting in an answer to the application. Upon the answer being put in, the matter came to be discussed before one of the Judges. Sir James Carnegie, in that answer, maintained several pleas. He maintained, in the first place, that the Montrose Harbour Trustees had no right to object to his proceedings; that their grants did not give them a sufficient title to object to his proceedings. He maintained, further, that his proceedings were in themselves the exercise of a right which belonged to him, and in particular belonged to him, in consequence of tracing the progress of the river in various places, and the alterations it had made,—that he was protecting his own ground and restoring ground that had been partially overflowed by the change of the course of the river; that formerly it had not been overflowed, and that even in its present state it was ground that was, as to a great portion of it, pasture ground, except at Spring tides. He maintained, finally, that the operations he was performing would not be injurious to the harbour of Montrose, and he stated reasons why they would not be injurious. The Judge, on considering the matter, was of opinion that the injunction ought to be recalled. Sir James Carnegie had made an offer of security for payment of any damages that should be found to result from his operations; that is to say, if instead of having a trial by a jury upon speculative evidence as to what would be the result of his operations, they should after experience of them be found practically to produce any evil result, he would be liable for the damage that accrued; and he found security—I believe unlimited security—for seven years, that being held a period sufficient to test the matter practically. The injunction was thereupon removed, but the Bill as it is called was passed to try the question; that is to say, the injunction was removed, but the suit was allowed to exist in order that it might be proceeded with if it should be found necessary to do so. The case was in that position when the papers came to me to consider. There was a report by Mr. Leslie, the engineer, saying that he considered the operations would be injurious to the harbour of Montrose. There had been a previous report by him to Sir James Carnegie, authorizing a part of the operations; but Mr. Leslie thought the remainder of the operations would be injurious to the harbour of Montrose. There was also a report by Mr. Rendel, who concurred in that view. He was at Dundee about some other matters, and there was a communication from the Admiralty to the Trustees of the Montrose Harbour, saying they might avail themselves of Mr. Rendel being there to consult with him. Mr. Blackadder had a different opinion from Mr. Leslie upon the subject, and Mr. George Buchanan had also a different opinion from Mr. Leslie. Mr. George Buchanan is a very eminent engineer, and his opinion upon such matters is considered of great weight. In that state of the matter, the papers were placed before me to consider what was best to be done. It appeared to me, in the first place, that the title of the Admiralty to sue in this matter, was doubtful, there was room for contending that, because there was a grant of the harbour to the Montrose Trustees, the interest in the harbour was thereby transferred; and it appeared to be the duty of the Montrose Harbour Trustees, if there was damage apprehended in the harbour, to defend that right. That raised a question of title, the interest was with them, and it was their province and duty to defend it. I thought Sir James Carnegie's objection to the title of the Montrose Harbour Trustees was not well founded; I thought they had a title to maintain the suit in their own names; but then I saw that the question of title, if persisted in by the Admiralty, would be a very difficult and tedious question, and that we should probably get into the House of Lords before we made any progress in the suit. I further saw that the issue of the question itself on the merits was exceedingly doubtful, that to persist in instituting a speculative inquiry into what would be the injury done to the harbour after the Court had disposed of the matter with the Harbour Trustees, by allowing the operations to proceed upon finding security for the consequences, would be attended with the greatest risk; and that it was not improbable that in such an investigation before a jury, we would be cast. I thought that the prudent course would be to wait for a time, say two or three years, and then see whether the evil apprehended was commencing to operate, and then we might go before a jury with the fact as established, and not with three or four engineers on one side, and three or four on the other side, speculating on

Lord Advocate of Scotland.

May 30, 1845.

whether it would be so or would not be so; for although I have every respect for those gentlemen of skill, yet I have seldom seen a case in which there were not as many on the one side as on the other. There would be a feeling of hardship, I think, in the minds of the jury with regard to the breaking down of embankments, which would expose our case to very great risk on a speculative inquiry. If it appears from experience that no practical injury arises, then I do not see any reason why I should advise the Admiralty to step out of their course, in order to have those embankments pulled down; on the contrary, I think they would not succeed with a jury in that case. If there is practical injury, I think they would succeed with a jury; and my view of the case was to let matters alone for a time, not to state our difficulties in any way, or to make them the subject of discussion in the court as to our title. If we found it practically injurious, then the course I had in contemplation was this, that the suit which is raised at the instance of the Montrose Trustees, which is called a suspension, should be revived, and that there would be an action of declarator to have the right fully declared at the instance of the Montrose Harbour Trustees and the Admiralty, and the officers of State, combining these three instances in the form of a declarator; so that if any question was raised as to the rights of the one, it could only be because the right was vested in the other; and in that way I think we should be able to come into court with the existence of a practical evil, which would overcome any feeling of hardship, and enable us to succeed in our suit; I have been of opinion that until we are in a condition to say that there is some practical injury, it would be a hazardous suit to embark in, and an adverse verdict in the speculative inquiry would be found to be a serious obstacle if practical injury should, after a time, be found to result from the operations.

1420. (*Mr. Hume.*) What is your view with regard to the power of the Crown, as you are aware that, by the Act of Charles, the Crown has a right to all lands below high-water mark. Does that power extend to Scotland?—We have a question just now in regard to the encroachments at Portobello, where the matter of the right of the Crown in regard to the shore is under discussion.

1421. Are you aware that, with respect to the Tay, two or three actions have taken place where the parties have been compelled to withdraw all the obstructions to the navigation within all below high water?—There are some cases about embankments on the Forth and the Clyde, which were the subject of discussion. We have the law under discussion in that Portobello case just now.

1422. (Mr. *Godson.*) In what stage is that case?—The discussion has arisen in the form of preparing issues for the jury. The Crown are there complaining of the encroachment, and the question comes to be, what is the extent of the rights of the Crown, in order to settle what issues we are entitled to take in the trial of the cause. That is to prevent encroachment. After damming out the sea, the party claims it to be his property. When a party embanks opposite to his lands, the property of the shore, generally speaking, belongs to him. There were some other cases, and we have all those cases referred to in this question at Portobello.

1423. What is the name of the case?—It is the Officers of State against Mr. Smith.

1424. Have a part of the encroachments been made under the direction of the engineer, Mr. Leslie?—Yes; part of Sir James Carnegie's operations appear to have been so made.

1425. By what authority would he do that?—He did it by no authority, so far as I know; but he being the engineer of the Montrose Harbour Trustees at the time was of opinion that the operation would be no injury, and he would maintain that opinion still.

1426. (Mr. *Hume.*) Was there any Minute of the Commissioners of Montrose Harbour, authorizing him as their officer to do so?—I do not understand that he bound the Montrose Harbour Trustees.

1427. (Mr. *Rice.*) Was Mr. Leslie the engineer of the Montrose Harbour Trustees?—He was at that time. It so appears from the papers.

1428. Are you of opinion that the grant to the Montrose Trustees superseded in any degree the rights of the Admiralty to interfere?—I think there is very considerable doubt upon that. My inclination of opinion is, that the Montrose Harbour Trustees are the proper pursuers of the action, and not the Admiralty.

1429. Are the Commission to understand from your opinion that the grant to the Montrose Trustees does in any degree supersede the right of the Admiralty to interfere in this case?—That is a question of very considerable doubt.

1430. (Mr. *Hume.*) If the Trustees of Montrose Harbour, as to whom there is a doubt whether the power given to them did not supersede the power of the Admiralty, have applied to the Admiralty, pointing out their inability to carry on the suit from want of means, and requested the interference of the Admiralty, would not that be sufficient authority for the Admiralty to proceed?—In that case, if the title was in the Montrose Harbour Trustees, the Admiralty would have to proceed in the name of the Montrose Harbour Trustees. But what I would recommend, if the fact is found to support the opinion of Mr. Rendel, would be that an action of declarator, an additional action, should be raised in the names of all the parties I have mentioned, and conjoined (as we call it) with the action that is already in Court, at the instance of the Montrose Harbour Trustees, so as to bar all difficulty of title, averring that injury has actually occurred, and concluding that the ground of it should be removed. I think that if we raised the simple action at the instance of the Admiralty now, we should be taken to the House of Lords on the title.

1431. (Mr. *Rice.*) It would be like so many counts in an indictment, in fact?—One question here is, who has the real title to sue. Sir James Carnegie pleads just now that the title is not in the Montrose Harbour Trustees. If the action had been brought at the instance of the Admiralty, I have no doubt Sir James Carnegie would have pleaded that it is in the Montrose Harbour Trustees, and not the Admiralty; or perhaps he would have raised a question, whether it is not really in the Crown itself, which is a doubtful matter also. If the officers of State,

Lord Advocate of Scotland.

May 30, 1845.

as representing the Crown itself, had brought the action alone, he would probably have said it was in the other parties. What I would recommend, if there is an actual injury proved to exist, is, that an action should be raised in the names of those three parties. Then Sir James Carnegie cannot say it is transferred to the Montrose Harbour Trustees; at least he cannot say it to any effect, because still the answer is that they are pursuers.

1432. (Mr. *Godson.*) In other words, that is similar to an interpleader here?—Perhaps it is; I am merely stating what I would recommend as the most likely mode of obtaining a verdict in this case.

1433. (Mr. *Hume.*) How long is it your intention to wait?—What I would say on that point is, that some engineer, who can be relied on, should go to look at the place, probably in the course of the autumn of the present year, to say whether he sees any practical injury arising, or, if not, in the course of the next spring. The security lasts seven years.

1434. Suppose the Commission already have reports from capable engineers of the injury done?—I am not talking of an opinion that injury may or will occur. Some engineers say that injury will occur, that there will be a certain degree of want of scouring of the harbour and silting up. Other engineers say that will not be the result. If they say, We have now examined it again, and there is a certain degree of injury already actually resulting, then I would say, commence your action, and come upon Sir James Carnegie for damages.

1435. (*Capt. Sir G. Bremer.*) What is the state of the embankments?—They are quite finished; they were finished before we took up the matter at all.

1436. (Mr. *Godson.*) Are the Commission to understand that the acts of Mr. Leslie have not in any way compromised the Admiralty?—I am of opinion, that in law, they have not; I have no doubt about that.

1437. In the case of the Queen against Smith, within what time is the judgment likely to be obtained, so as to state what is the real law with respect to pulling down embankments or encroachments?—I should think it will be disposed of in the course of this summer session.

1438. Is there any fact that will at all impede the judges in giving an opinion upon the law?—No, I think not.

1439. (Mr. *Hume.*) The question is, who is the proprietor of the property so embanked, is it not?—No; the question is, whether Mr. Smith is entitled to encroach on the shore of Portobello, or whether the Crown is entitled to prevent him: he has built a wall, and he was allowed to complete the wall under a notice that that should not interfere in any way with the right of challenge; he had got it up about 4 or 5 feet, and he was allowed to add another foot to it.

1440. (Mr. *Godson.*) In that case must an opinion be given, aye or no, what is the power?—Yes, what is the extent of the Crown's right of interference.

1441. (*Chairman.*) Will you be so good as to state to the Commission generally any legal decisions that your Lordship may happen to remember relative to embankments of land or encroachments upon rivers or harbours, as on the Clyde, Tay, or elsewhere?—Some questions arose in regard to the powers of the River Clyde Trustees who had made embankments for the navigation of the river, to narrow the stream and eddy, deepening the channel in that way. The land gained on each side accrued to the proprietors by a reserving clause in the Clyde Navigation Act. The Navigation Trustees were advised that embanking the river and making it so narrow was not an expedient thing for the navigation, and they proposed to demolish part of that embankment. Some of the proprietors resisted, and said, "This land is ours, and you must not touch it; or, at least, you must give us compensation." In that case the Navigation Trustees contended, and successfully, to my recollection, before Lord Jeffrey, that the primary object was the navigation of the river, and that though they tried this experiment of embanking they were equally entitled to try how it would do without embanking, and that, in point of fact, there was nothing to prevent them, if they found the experiment unsuccessful, from restoring the alveus of the river. The Court, and afterwards the House of Lords, gave effect to the views of the trustees.

1442. (Mr. *Hume.*) Is it not the case that by a decision, payment for certain alveus, or ground recovered from the river, was stopped to those alleged proprietors who claimed it, and that it is now reserved and held for the Government?—That is a different case; that is a question which turns entirely upon the interpretation of certain clauses in the statute. It is a question whether the Crown is entitled to a certain portion of the damages that are to be recovered for certain property on the banks of the Clyde.

1443. Is it not the shore of the land?—It is the shore of the land that formerly was the bed of the river; but the question turns on the clause of the Act of Parliament, which provide specially for that case in the Clyde Navigation Act; it does not rest on general law; it turns on the provisions of the Act.

1444. Do you think that the private Act of the trustees superseded the general law of the land?—There was a special provision as to the disposal of the money that was to be got from that subject. It was specially disposed of by the Act of Parliament.

1445. Do you think that precludes the power of the Crown to assert any claim to that property?—The assent of the Crown I understood was given to the Act; and when the Act does dispose of the money, we must deal with it according as the Act disposes of it; and the question arises whether, under the terms of the Act, a certain portion of it does not belong to the trustees.

1446. (Mr. *Godson.*) Having stated that the Crown has a right to pull down these embankments, is there any law in Scotland as to the time, so as to limit the Crown at all in point of time for pulling them down?—It is still a moot point how far prescription runs against the Crown; whether the Crown can suffer by the negligence of its officers.

1447. Assuming for a moment that it could suffer, is any time limited within which it should occur?—Forty years.

1448. (*Capt. Washington.*) According to the decision in the case you have just mentioned, would not the Clyde Trustees have power to pull down any part of the embankments which they thought necessary for the benefit of the navigation within the limits of the river up to high water mark?—I think they would.

Lord Advocate of Scotland.

May 30, 1845.

1449. Will your lordship be good enough to name the cases you refer to?—One case which I have already referred to was that of Todd against The Clyde Trustees, affirmed in the House of Lords in 1841, reported in the 2nd vol. of Robinson's Appeal Cases. I may refer the Committee to the following cases:—Smart *v.* Magistrates of Dundee, 1797, 8 Brown's Cases of Parliament; Magistrates of Culross *v.* Geddes, 1809; Leven *v.* Magistrates of Burntisland, 1812; Campbell *v.* Brown, 1813; Boucher *v.* Crawfurd, 1814; Berry *v.* Holden, 1840.

1450. (Mr. *Hume.*) Will your lordship be good enough to define what is meant by the term "alveus," which has been repeatedly used before this Commission?—It is a term frequently used to denote the bed or channel of a river.

[*The Witness withdrew.*]

Capt. Henry Mangles Denham, R.N., and F.R.S., further examined.

Capt. H. M. Denham, R.N.

May 30, 1845.

[*Capt. Denham's Plans of Morecambe Bay and of the Duddon Estuary were laid on the table.*]

1451. (*Chairman.*) In your examination of the north-west coast of England did you survey the Duddon water?—Yes.

1452. You are aware of the line on which the Whitehaven and Furness Junction Railroad proposes to cross that water by a solid embankment?—I am aware of the line; but I was not aware that it was to be a solid embankment.

1453. State to the Commission your opinion as to whether, with due regard to the present and prospective interests of navigation, a solid embankment is desirable, and what in your opinion would be its effect upon the navigation?—It would cut off certain vessels which now go up to the Broughton quarries, and such vessels as carry coal, manure, and limestone up and down, which is very trifling; and as the estuary presents no refuge capacity, I consider that an embankment right across, if crossed at all, would be more beneficial solid than open.

1454. What depth of water is there in the proposed line?—Twenty feet in the channel at high water ordinary spring tides.

1455. How far is that below the point of navigation?—Three miles below the Broughton quarry shipping place.

1456. (Mr. *Godson.*) What is the name of the Broughton quarry shipping place?—The Burlington Slate Quarries.

1457. (*Chairman.*) How much further up to Broughton?—Four and a half miles below where vessels drawing six feet can reach at high water spring tide.

1458. (Mr. *Hume.*) Do any wherries or flat-bottom boats go higher up than 4½ miles?—Open punts up to Duddon Bridge.

1459. Is there any flow of the tide above Duddon Bridge?—There is when great tides occur, but rarely, above ½ a mile.

1460. (*Capt. Beaufort.*) What is the rate of the flow of the tide up and down at the proposed place of embankment?—Three knots on the flood and 3½ on the ebb.

1461. Would not that be entirely put a stop to by the embankment?—It would.

1462. Consequently, would not the parts of the country above that embankment be deprived of the benefit of water-carriage?—To those places to which I have alluded.

1463. Would not the whole surrounding country be equally deprived of it?—From the trade I am at all aware of, I imagine it would be a very slight privation to the country in general.

1464. Will you state what extent of country round the estuary is supplied, or can be supplied, either for landing or shipping?—It is difficult to estimate that.

1465. Is not this estuary the outlet for the waters from the Duddon and Kirby Pool?—Yes; but neither of those waters bear down any traffic that I am aware of.

1466. (*Capt. Washington.*) Are there not large slate-quarries belonging to the Earl of Burlington on the banks of Kirby Pool?—There are, but so useless is the estuary considered to them that his Lordship has determined to form a railroad independent of the estuary, to get rid of the constant demurrage which the detention of tide has occasioned, and that railroad is to come down to Piel Harbour.

1467. (Mr. *Godson.*) There is one already down to Piel Harbour now being made, is there not?—Yes.

1468. Is the railroad now proposed to come into that small line of six miles long?—Yes.

1469. Supposing an embankment to be made where it is proposed to make one, how many square miles of country is the estuary the means of draining?—Duddon Bridge at once provides for all the water that comes down from the lakes. Kirby Pool has its own sluice-gate and bridge. Simpson's Beck and Salt-house Pool have each a bridge and sluice-gate that provide for all the outlet, and to exclude any tidal-water that it is desirable to exclude in high tides.

1470. After the tide is gone down, does it not all come down the channel, across which it is the intention to put the embankment?—Decidedly, and there forms a main trunk.

1471. Having taken away all that flow of water above the embankment, in what way would you keep the channel open below the embankment?—I consider when an embankment is driven across the designed part that no channel would be desirable for navigable purposes.

1472. Then are the Commission to understand that, in your opinion, the placing of the

Capt. H. M. Denham, R.N.

May 30, 1845.

embankment will destroy the whole of the Duddon Estuary as to navigable purposes?—It wholly destroys it.

1473. (Mr. *Hume.*) Can you estimate the quantity of water at high spring-tide that covers that estuary above where the embankment is proposed?—Assuming the area at 5000 acres, and the average depth at a mean of spring and neap tides at 6 feet, it would exclude about 1300 millions cubic feet of water on every tide.

1474. (Mr. *Godson.*) It having been stated to the Commission that it is to be a solid embankment, to be made by means of stones driven down gradually and the sand silted up, will you state in what way the waters above that embankment are to be disposed of?—They could not be disposed of at all if the embankment was without sluice-gates.

1475. Would it not require therefore some new channel to be cut through another part of the land to get into the lower part?—That would be one way of disposing of the waters.

1476. Would that assist or not assist keeping the part below and towards the sea in a navigable state?—I think it would not, inasmuch as the river now, with all the outfall of the tidal-water, does not preserve a channel at all that is navigable at low water; so do I not think that the river merely passing down with all the backwater cut off would be more than making its escape through gutter-ways that would never be navigable.

1477. Are the Commission to understand that the cutting a passage through the land, so as to dispose of the water above the embankment, by introducing it again into the estuary below the embankment, would or would not affect the navigation of the part below the embankment?—Not to any navigable purposes.

1478. It would not assist it?—It would not; it would be futile.

1479. (*Chairman.*) From your knowledge of the country, can you point out any eligible line of road by which public accommodation may be secured, and at the same time the rights of navigation preserved?—Yes; I conceive that that railway may be carried for the purposes intended, by going up one side of the estuary and down the other.

1480. How much further round would it be by going up one side of the estuary and down the other?—Eight miles in circuit.

1481. In your opinion, by following the course you would recommend, you do not interfere with the navigation of the waters at all?—A few stone or coal flats could go at spring tides above that.

1482. (Mr. *Hume.*) What kind of a bridge or passage do you propose for that three-quarters of a mile without injury to the navigation?—I would not recommend anything like a swing bridge, or any bridge that could pass vessels, in the railway across. A bridge that would be proper to let the river freshes out could not be a bridge that would allow vessels to pass up at any time.

1483. (Mr. *Rice.*) It could only be an embankment with arches?—Yes.

1484. In your former evidence you produced some plans with regard to a supposed crossing of Morecambe Bay?—Yes.

1485. Would you recommend a similar construction in the event of the railway being constructed?—Yes.

1486. (Mr. *Godson.*) Have you ascertained how deep the sand is, so as to know whether rubble stones would make a foundation?—Yes.

1487. About what depth is the sand?—From 9 to 10 feet.

1488. Would you not require to have something put down at the bottom of those 9 or 10 feet before the rubble stones would take any hold, by which they could be kept in their place?—Piles would be driven into the clay or marl.

1489. Then between those piles you drop the stones, do you not?—Yes, until we come above the sand.

1490. Then you would trust to the tide bringing more sand, as you gradually drop other stones down?—Yes.

1491. And thus you would rise higher and higher?—Yes, until the tide was shut out.

1492. (Mr. *Hume.*) What was the nature of the plan for Morecambe Bay; did you leave any water way, and how much across the sand?—I did not then speak of leaving a water way, but I stated the amount of waters that would have to be provided for, showing the bridges and culverts that now provide for it.

1493. Do you propose to provide for the same waters in that embankment, in case it should cross Morecambe Bay?—Yes.

1494. (Mr. *Godson.*) By the words "providing for the waters," do you mean they would go down their own channel, or have new channels for them?—In enclosing the interior part, the rivers would not be left to take their own course, but would be embanked laterally by dykes, and conducted down to the proper orifice in the embankment.

1495. (Mr. *Hume.*) Do you contemplate the shutting out the flow of the tide above that embankment?—Quite so.

1496. Do you, in the embankment at that place, contemplate also shutting out the tide there?—Certainly, without which it would be no boon to the public. I consider the water traffic so unimportant that if the embankment was carried across it would be better solid than open.

1497. (Mr. *Rice.*) Are you aware of the proposed cut alluded to by Mr. Stephenson?—Yes.

1498. (*Capt. Beaufort.*) You stated that the Duddon never can be turned to any useful purpose for a refuge for ships in distress?—Yes.

1499. Might not a judicious system of dredging so as to straighten some of those channels, placing buoys and beacons, contrive to leave an open channel through which ships could go in distress?—I think not.

1500. Could nothing be done by the skill of the engineer?—I think not. The bar extends so far outside the line of coast right and left, that I consider it would be perfectly hopeless. *Capt. H. M. Denham*, R.N. May 30, 1845.

1501. How many miles is the five-fathom line from the north point of entrance of the Duddon?—Two nautic miles.

1502. At such a distance, you think nothing could be done to save a ship in crossing a two-mile bank?—Nothing more than now exists when the tide lifts; for instance, there are several tracks where there would be 20 feet, that would enable vessels to cross those banks.

1503. The question was, whether a judicious system of engineering would not keep the channel open out to that five-fathom edge?—I think not.

1504. (Mr. *Hume.*) There appears to be an embankment from Salt House Pool. Can you state what it was for?—It was embanked by the late Lord Lonsdale in 1830 for the redemption of 260 acres of land over which the sea ranged.

1505. Are you aware what depth of water flowed over those lands?—I should think at high-water spring about 2 feet.

1506. What quantity of water would that exclude?—Seven and a half million cubic feet.

1507. Were there any other banks in that estuary to exclude the tidal waters?—Yes; there are several running down on each side.

1508. The object of which was to exclude the water and reclaim the land, was it not?—Yes.

1509. (*Capt. Beaufort.*) Can you state whether you think it probable that a railway could be made without great engineering expense to the north of Millom hill?—Not very well to the north, but immediately to the southward.

1510. (Mr. *Godson.*) Supposing a railway to be taken from Poulton on the Lancaster side of Morecambe Bay to Cowper Point on the promontory of Cartmell to Chapel Island, and from Chapel Island to the mainland on the north-eastern side of Morecambe Bay so as to join the Whitehaven and Furness Railway across the Duddon Sands, in your opinion, what would be the injury to the navigation of Morecambe Bay?—It would be shutting up the Ulverstone Canal foot, which admits vessels drawing 13 feet water at high tide spring. It would shut up the intercourse with the river Severn, which is navigable up to the gunpowder-works of Blind Bridge, a distance of 3 miles and a half, also to the Quay's Green Odd, to where vessels of 10 feet draught of water arrive, also 3 miles above on the Ulverstone side. It would shut out all intercourse with the grange district 4 miles above the embankment, such coasters as now trade with Milnthorpe 8 miles above. So far I have alluded to existing coasting trade. It would then interdict for ever the formation of the new harbour, which I see so practicable for the restoration of the trade of Lancaster at Poulton Ring. It would also shut out a hundred or so of boats which carry on shrimp-taking and other fishing.

1511. Name a few of the rivers, the scouring of which assists the navigation that would then be shut out, and the quantity of water?—The Leven, Rusland Pool, the Crake, the Crakbeik, the Kent, the Gilpin, the Beetha, the Whinster, the Ulpha Pool, and the Keer.

1512. (Mr. *Hume.*) State to the Commission your opinion whether, with a due regard to the present and the prospective interests of the navigation, such an embankment is desirable?—I should say that, with the exception of the projected new port at Lancaster, the advantage would be in favour of the public by the embankment.

1513. Would not the shutting out so large a quantity of water as that which you have now stated to come tend very much to allow the channel to silt up?—I think it would silt up the different channels that now stand between the spits of the banks.

1514. Would not that be injurious to the navigation?—Not to the navigation of the three early tide ports, that now stand below that line.

1515. Which are they?—The Lune, the Wyre, and Piel Harbour. To all above it would destroy it, as well as the projected new port at Poulton.

1516. (*Capt. Beaufort.*) Deposition would go on still from those three rivers that are left open?—Not as it does now. To entrap the silt that now comes down would be a work of artificial effort; it would render them purer as they came out into the bay.

1517. After that was effected they would not go on depositing outside?—I think there would not be that dipping down which now keeps the Lune Deep open and so deep as it is, but as it is so unnecessarily deep, it would be ages before it would silt up so as to be of any consequence to navigation.

1518. (Mr. *Hume.*) In your survey around the Duddon waters and Morecambe Bay, did you observe embankments on either side, being encroachments, to keep out the tidal waters?—Yes.

1519. Are there many?—Not so many after you get to the southward of the Duddon, after you get into Lancashire.

1520. But in the Duddon there is the one now stated of 260 acres, and there are several others above, that you have mentioned?—Yes.

1521. Did you examine the extent of any of the other embankments?—Their actual sea face I did, but not the quantity of ground that they take in. That is being fully developed by the Ordnance survey.

1522. Did they in your view exclude any large portion of water from the respective places?—Yes, but not such water as one would covet for the sake of scour.

1523. Do not all waters that flow up tend to scour in their return?—It depends on the marginal nature I may say of the estuary. Tidal water would come in clear and go off as thick as mud from the frittering away of the shores as it comes in, and that water goes out inimically to the bars of the estuary, instead of cleaning it in proportion to the scour.

Capt. H. M. Denham, R.N.

May 30, 1845.

1524. Then what water is it in your opinion that does assist the scour of bars?—All the water that comes in, however thick, will assist in keeping open a channel, if it is only a gutter-way; but in proportion as that is kept open, so the bar progresses seaward, and the shelves extend off shore.

1525. Carrying it into deeper water, and consequently rendering the harbour more accessible?—Rendering it by degrees like Liverpool more inaccessible, as time goes on, and from the manner the soundings are carried out, we see exactly where all the shelves are rising.

1526. Having seen them, are you able to state in what way any measures as preventives can be now taken to guard against the result you look to?—I think that where the bar has extended to what I term the vanishing point of the velocity of the ebb tide, that is supposing the ebb tide went eight or 10 miles down, there when once the accumulation begins to take place it will go on aggravating itself, and then it is hopeless, it will always be there accumulating; but wherever the bar lies within the range of the whole transit of the ebb tide there is a chance of artificial effort being successful.

1527. Must not the accumulation of that bank depend on the depth of the water to which the ebb tide would carry the silt and mud?—Not so much as to the depth as to the cross of fair channel stream. Take the Wyre as an instance of a little estuary emptying itself; it has come down from time immemorial; that bar is at the same distance that it was, two miles. I attribute that entirely to all the sediment of the Wyre coming down, being cut off at right angles by a more powerful stream, called the Lune Stream. If I take the Duddon, I find that it is projecting, consequently adding, and it will go on adding till it gets into the fair set of the Irish Sea ebb and flood, clear of the points of the adjacent lands. The bar will project, and always try to get up to low water level at neap tide, and though it may tumble into 40 feet water directly, yet it will then be a steep-to sort of shelf, instead of having worn to a gradual shoal, it presents to my mind a much more dangerous bar than before, when lying within the range of coast.

1528. (Mr. *Rice.*) In answer to a former question put to you by Captain Beaufort, did you mean to say it was impossible for an engineer to make a channel, or that you thought, looking to the comparative advantage of the expense, it would not be desirable?—I look really to the total impossibility; that is, if you had all the dredging or excavation means to work during one tide, that the next tide would fill it up, or nearly so, and there would be no permanency whatever in it. When I perceive any estuary representing a prostrate cone, with its base outwards, I give it up as likely to produce any permanent channel through its sands.

1529. (*Capt. Beaufort.*) Is not that the character of all estuaries?—No; we have before us a case in point, the Dee and the Mersey. The Mersey may be represented as a bottle, with its neck outward, and the impetus of the backwater through the straits of three or four miles, with very high banks seaward, called the Burbo Banks, allows a channel of four miles to be kept down towards the northern horn of the bay, called Formby, and there it breaks off seaward; but in proportion as it expands a deposit takes place, and is still taking place. But the difference for navigable purposes between the Mersey and Dee is, that the Dee does not conduct any force, but loses it from the first moment of emptying itself. It extends as far as it can into the Irish Sea, where the Irish Sea stream cuts off westward laterally to the shore towards Holyhead, and the line of that sea twisting and closing as it goes; so that, in fact, the bar of the Dee is as much leeward of its orifice as it is directly seaward of it.

1530. (Mr. *Hume.*) Do you mean that the sand and material carried down by the stream of the Dee is swept by the stronger current of the Irish ocean towards Holyhead, in that direction?—Yes, with also the emptying of the Mersey, which is above it on the ebb.

1531. Do you consider that that bank at the mouth of the Mersey is forming where there is an eddy between the stream from the Mersey and the stream from the Channel?—Yes.

1532. And that wherever an eddy of that kind exists on the coast by streams meeting, there is a danger of the formation of these banks?—Yes; but in such a case as the bank that extends between the promontory which divides the Mersey from the Dee, it is owing to the bank that extends outward from that promontory that we have any channel at all on either side, that is, for the rivers themselves. If the Burbo and the East Hoyle Bank did not exist, the water of the Mersey would turn short round and spread itself over the mouth of the Dee.

1533. (Mr. *Rice.*) You mean to say that the effect on the outer current of the sea is to carry part of the deposit that comes from the Mersey, and to deposit it at the mouth of the Dee?—Yes; going back to the first conception that the mouth of the Dee presents a prostrate cone and loses its power from the moment it begins to ebb instead of obtaining an increased power, as the emptying of the Mersey estuary does.

1534. (Mr. *Hume.*) What are the best means you can suggest to the Board for keeping open rivers and estuaries, such as you have stated?—To take a case more completely before the Commission, I will take the Sunderland shoulder that projects from the Lune as a tongue formed by the exit of the Lune on the one side and the outfall of the Morecambe Bay waters on the other; and answering the question, I would say, that the only chance of improving the Lune navigation down its sea reach of sand would be, if possible, (which I believe to be an engineering possibility,) to embank that tongue on its river and sea face.

1535. Do you mean by that to narrow the ebb so as to throw it on a particular channel, giving it more force by contracting its ebb?—A most essential advantage would arise from the cross set of the bay tide not setting across that channel.

1536. If the embankment was so formed, would not the exuvia and silt be carried further out and prolong that tongue which is now an objection?—Yes; it would go on feeding in this case till it got into the Lune Deep, and there it would be arrested, and for a time having so much more depth to feed up the other, it could only be arrested in its advance by the strong tide coming across it.

Capt. H. M. Denham, R.N.

May 30, 1845.

1537. (Mr. *Godson.*) Would any embankment across the Morecambe Bay at the place proposed have any effect on the sea-reach sand at the mouth of the Lune?—I consider that it would have a beneficial effect.

1538. In what way would it have a beneficial effect on the sea-reach sands at the mouth of the Lune?—The Sunderland Shoulder is so fed by the scour of the upper banks and soil of Morecambe Bay by the powerful outfall which now exists, that anything that would diminish that powerful outfall would tend to bring less down upon Sunderland Shoulder and Cockerham Bank which now form the sea-reach, giving the scour of the Lune itself more effect than it now can maintain.

1539. Would not the effect of an embankment across the bay be to alter the direction in which the tide will come in and out?—The tendency of the tide would be altered; but I conceive an advantage would arise from that alteration.

1540. As a matter of science, can you predict the way in which the tide would go after you have made an embankment of 12 miles across the bay?—Certainly: we have then decided elements to guide us.

1541. *(Captain Beaufort.)* Would not the method you propose to pursue with respect to the river Lune, in walling the sides and conducting the stream down, apply to the rivers Kent and Leven in bringing two channels down completely into the offing?—If I may point out the Cartmell wharfs as resulting from the same directing influence of ebb-tides as the Sunderland Shoulder is produced by the promontory of Heysham, I should then say that if Cartmell Wharf be walled up as far as it now dries out to low-water neaps, a more permanent direction and deeper capacity would be given to the Leven on the northern side and the Kent and other rivers which pour into the Kent on the southern.

1542. It would have the effect by deepening?—It would.

1543. What is the cause of the Lune Deep?—Looking at the Lune Deep lying between the two extremes of the arm of Morecambe Bay, Walney Point and Rossall Point, eight miles across, Lune Deep, lies one-fourth nearer to the Rossall side, I conceive that the submarine matter on either side of the Lune Deep is that of original formation and not of deposit. I, therefore consider Lune Deep as the original outlet of the Lune waters and Morecambe Bay rivers at a time when three-fourths of the now under-water surface to the northward was solid *terra firma*, and hence the cause of Lune Deep.

1544. What prevents the sand filling up Lune Deep as well as the adjacent parts, which, according to your statement, it has filled up?—It has filled up no place by deposit right or left, but it has filled up vastly in the interior part. There having been an original dyke, the rush of flood-tide into that bay, as fast as the bay became scooped out on its margins, and which is daily going on, it is scooped by the tide either way; the tide dips down to the last, with all the outfall of Morecambe Bay; looking at the channel right and left, and at the body of flood-tide necessary to fill that bay, the pressure back is quite an equivalent to what is brought down at the head of it, so as to avert its filling up rapidly.

1545. As soon as Morecambe Bay should be cut off by an embankment, the water let in, and the outfall from that again when that has ceased, and the course of the tide consequently altered, would not then the sand break in immediately and Lune Deep be filled up?—Yes; but very slowly.

[*The Witness withdrew.*]

The Earl of Lonsdale.

The *Earl of Lonsdale*, Chairman of the Whitehaven and Furness Railway, examined.

1546. (Mr. *Hume.*) Is your lordship proprietor of any portion of land on either side of Duddon estuary?—About 1000 acres.

1547. On the maps there is an embankment, stated to have been made by the late Earl of Lonsdale, a few years ago, to the extent of between 200 and 300 acres; under what authority was that enclosed?—Under the Millom Enclosure Act.

1548. In what year did that pass?—On the 22d of June, 1820.

1549. What is the object of that Act; is it to enclose more land?—Yes.

1550. Will you state what extent of land under that Act you could enclose?—About 1000 acres.

1551. In what direction from that embankment?—Up to what is called the mid stream.

1552. Was that Bill passed solely to enclose that part or any other part of the estuary?—It was a Bill to enclose all the wastes in the parish of Millom, and that allotment was given to my family.

1553. Was there any opposition to that embankment?—None at all.

1554. Do you know whether the opinion of the Admiralty of the day was given, as to whether that would injure or interfere with the navigation?—I should think not.

1555. Do you as proprietor consider that you have a right to the land under the high-water mark, if you can enclose it?—Yes; but it is nearly all low water; all that land is dry at low water.

1556. Is it always covered during flood?—Yes.

1557. (Mr. *Rice.*) Is there any boundary to the enclosure?—There is the Commissioners' award.

1558. You mention mid channel, is that the boundary?—Yes.

1559. (Mr. *Hume.*) Do you know whether there is any Bill that has passed for enclosing any other portion of the Duddon estuary?—I am not aware of it.

1560. If an embankment was formed across Duddon, at the place stated by Mr. Stephenson, is there any intention to carry on that line further across any portion of Morecambe Bay?—

The Earl of Lonsdale.

May 30, 1845.

This Bill is to cross the Duddon sand. There is a projected railroad, which is not now before Parliament, to cross higher up, but it takes a very small portion of the sand, as compared with the former project of crossing the Duddon.

1561. There is no Bill for that introduced as yet?—No.

1562. The Bill for which you appear is the one for crossing the Duddon Sand, as stated by Mr. Stephenson?—Yes.

[*The Witness withdrew.*]

Mr. *J. Leslie.*

Mr. *James Leslie,* of Dundee, M. Inst. Civil Engineers, further examined.

1563. (Mr. *Hume.*) Have you acted as engineer to the Commissioners of Montrose Harbour?—Yes.

1564. Since what year?—The Harbour Bill passed in 1837, and I acted as their engineer until about 1843, when the new dock they have constructed was finished; I am so still, but they have no work doing just now.

1565. During the time you have been their engineer have you been consulted, or given any opinion to Sir James Carnegie, respecting the enclosure of land in the basin of Montrose?—Not regarding the enclosure of land; I was consulted by Sir James Carnegie in 1841 about the best mode of protecting his land from being encroached upon by the River South Esk, and I recommended that he should divert the channel of the river a little, which he did.

1566. Will you explain what was your object in the report that you made to Sir James Carnegie?—The river was cutting the land very much on the south side, and he stated that he had been advised by Mr. Blackadder, civil engineer, to turn the channel of the river into what had been its course formerly, and I agreed with Mr. Blackadder that that was the best thing Sir James Carnegie could do, and advised him accordingly. The letter to me was asking me to come and advise him about the protection of his land on the South Esk. When I met him at the place appointed, he hinted at his wish to embank land, and I told him I thought he had better not attempt it, because the trustees of Montrose Harbour would decidedly object to it, as they had been cautioned by Mr. Walker, civil engineer, to watch and resist any encroachments on the basin, which he called the "lungs of the harbour." Sir James built an embankment on the side of the river, so as to change the channel that year, and then next year, without saying anything to anybody, he ran an embankment across the whole lower end of it, and shut out the water.

1567. Would that embankment which you recommended have prevented the South Esk from cutting his land, but at the same time have allowed the flow of the tide upwards?—The flow of the tide would have been just the same as before; it merely changed the channel of the river.

1568. And would have prevented any portion of his land being cut off by the flood of the Esk?—Yes.

1569. There would have been no interruption to the flow of the tide?—None.

1570. Did you in giving that advice give him the advice as engineer to the Montrose Harbour, or independent of that?—Quite independent of that; I had no idea there was to be anything affecting Montrose Harbour.

1571. Did you report to the Commissioners that you had given that advice?—At that time I do not think I did, because it seemed to me not to be a matter affecting the harbour of Montrose.

1572. Are you aware whether the Commissioners gave any sanction to Sir James Carnegie to make that embankment along the river?—No previous sanction; but they went up one time to see what he was doing, after the work had been commenced, and having examined the embankment and heard the statement and explanations of Mr. Lyall, the factor, they returned perfectly satisfied that what he was doing was no harm to Montrose Harbour.

1573. That was the first year he defended himself from the South Esk?—Yes.

1574. Afterwards, when he enclosed the ground and shut out the tide, do you know whether the Commissioners of Montrose took any notice of it?—Not until the work was far advanced and the water excluded, because they did not know sooner. One day, when I was at Montrose, I heard of it accidentally and told them of it, and when they heard of it they objected.

1575. They never, as far as you know, gave their sanction to any enclosure that would shut out the tide?—Certainly not.

1576. What area has been enclosed?—About 62½ acres on the east, and 3½ on the west side of the new river channel.

2577. What authority have you for believing that the ancient stream of the river was to the north of that line that formerly existed?—I think I saw it marked on some old plan.

5578. But although the stream was there, yet the tide flowed over the land south of that stream?—Certainly.

5579. Then the basin has been reduced in size by that enclosure of 66 acres?—Yes.

5580. Are you aware what depth of water used to flow over that?—About 4 feet on an average at spring tides.

1581. (*Capt. Washington.*) Taking the area at 66 acres, and the mean depth at high water at 4 feet, would not that exclude about 4,000,000 cubic feet of water on every tide?—Fully 4,000,000 at neaps, and 12,000,000 at springs.

1581* Are you acquainted with the embankment marked in the map 1831?—Yes.

1582. Is it not on Sir James Carnegie's property?—Yes.

1583. Then it appears that the embankment of 1842 of 66 acres is the second embankment of nearly similar extent, or is in addition to that made in 1831?—Yes.

1584. Are you aware whether that was ever covered by the water?—I know it was covered with the water; I know it by the levels.

1585. To what extent is the level of the land there below the ordinary level?—I suppose it is much about the same level as the part more recently enclosed.

1586. What is the level below high water of the embankment of 1842?—At ordinary spring tides I suppose it is about 4 feet of water.

1587. Then assuming that space embanked, as it appears by the map now on the table, to be 50 acres in extent, has not the embankment of 1831 excluded about 3,000,000 cubic feet of water in every tide in addition to the four millions excluded by that of 1842?—I conceive so; and that in spring tides it would exclude 9,000,000 cubic feet of water.

1588. (Mr. *Hume.*) In bringing the recent embankment to the notice of the Commissioners of Montrose Harbour, did you do so under a belief or an opinion that that enclosure would injure the navigation of the harbour?—Yes.

1589. Is it your opinion that shutting out the tidal water by enclosures of that nature tends to lessen the ebb, and consequently encourage the deposition of silt?—Decidedly so.

1590. What other rivers have you been employed on as an engineer?—I am engineer to the Dundee Harbour Trustees.

1591. Have you attended to the encroachments that have been made on the Tay River?—Yes.

1592. Will you state what encroachments have come more immediately under your notice?—The encroachment that has come more immediately under my notice is this: there is a long wall built for Lord Kinnaird projecting at right angles from the north shore of the Tay.

1593. In what part?—Near Powgavie, about six miles above Dundee.

1594. Did you, as engineer to the Dundee Harbour Commissioners, point that out to them as a work likely to be injurious to the harbour?—I did.

1595. In what year did you make the report?—That was about 18 months ago.

1596. Have any proceedings been taken by the Commissioners to remove that wall?—No legal proceedings have been taken. I thought it better they should have a higher authority, and I advised them to get some other person to look at it, and they employed Mr. James Walker, civil engineer; he went there, and reported that the wall was injurious, and that it ought to be pulled down. The trustees have taken no legal steps, but they have given notice to Lord Kinnaird that if he does not remove the wall they will take legal measures.

1597. What length of wall is that to which you allude?—About 3100 feet long.

1598. What would be the effect of that wall if allowed to continue?—It causes a silting up on the north shore.

1599. On both sides of the wall?—Yes.

1600. To what extent, if allowed to continue, would it silt up?—It is difficult to say how much, but if all the walls that are now building on that side of the Tay were completed, and if all the land was silted up within the points of those walls, it would form an area of three square miles, or about one-ninth of the area of the Tay between Dundee and the mouth of the Earn.

1601. Are there other walls built up?—A great many.

1602. By whom?—Mr. Allen, of Errol; Mr. Hunter, of Seaside, and others.

1603. Do you consider these to be encroachments on the navigation?—They are encroachments. The same notice, I think, was sent to the whole of the parties who had been encroaching.

1604. Are the Commission to understand that the encroachments already commenced will, if completed, comprise nearly 2000 acres?—Yes.

1605. In your duty, as engineer, have you pointed out any other impediment to the navigation of the Tay?—Yes; I proposed two years ago to build a wall above the harbour, and to cut away a projecting point of rock at a place called Magdalen Yard.

1606. Is that with a view of setting the current past the sea face of the docks at Dundee?—Yes.

1607. You are aware of a bank called the Middle Bank, extending on the south side, opposite Dundee, a considerable way down the middle of the Tay?—Yes.

1608. Have you been able to form an opinion as to the cause of that bank, and whether it is increasing or decreasing?—I do not know that it is increasing or decreasing. There are banks all the way up the Tay above that, but there are none below it; and the reason there are none below it is because the Tay is contracted after that.

1609. Do you mean that the current below that is so strong that none is allowed to form?—Yes; the channel is narrow compared with the great space to be filled above, and no banks form there.

1610. Are there any points on the south side that set the current off from that, and thus leave a bank to be formed in the eddy?—There is a long bank on the south side further up, called Balmerino Bank.

1611. Can that have the effect of causing an eddy on the spot where the large bank is formed?—I cannot say; the ebb tide sets very strongly against the south shore, opposite Dundee.

1612. Have the Commissioners of the harbour been anxious to deepen the water to the extent of their limits; how far do the Commissioners go up?—The power to execute works only goes as far as the harbour itself, but their boundary as a harbour for collecting dues goes nearly four miles above, to Invergowrie.

1613. Have they done any works up to that extent with a view to deepen the river?—They have not deepened the river; they have removed some rocks opposite the harbour; we tried one year to dredge away the ballast bank.

Mr. *J. Leslie.*

May 30, 1845.

1614. Did you succeed?—No; for want of another operation being done above—cutting away the point of rock; it did not succeed; it filled up again.

1615. Are you acquainted with the operation carried on in the upper part of the river by Messrs. Stevenson?—Yes.

1616. What has been the effect of those operations on the navigation?—They have got a considerable additional depth, I believe, in the upper part of the Tay.

1617. Has that been caused by removing the fords and projecting parts in the river and fishing cairns?—Yes; by removing large stones, and dredging and straightening the channel, and removing sinuosities.

1618. Is it your deliberate opinion that that is the best mode of improving the navigation?—For the upper part I think that is decidedly the best plan, but it will not do to persevere with it all the way down to the ocean.

1619. Why not?—Because you would have a bar at the mouth of the river where you come to join the ocean. In my opinion you must have a large estuary within to make the scour over this bar, or otherwise it would get shallow.

1620. Have you not in the Tay a very large estuary for that scour?—Yes.

1621. Will not that scour be increased by every means that increases the volume of the flood?—Certainly.

1622. Then you are of opinion that the measures taken by the Perth navigation are judicious, and likely to benefit navigation below as well as above?—I do not know that it will benefit the navigation below; I do not think it will affect the navigation below at all.

1623. Will it not admit a large portion of water?—It is very trifling; but in principle, of course, it would.

1624. What is the principle that you allude to, which you would recommend to be observed in tidal rivers and harbours?—I think when you have an estuary you should endeavour if possible to preserve it entire, and not allow it to be diminished, so that you may keep the great scour over the bar at the mouth of it, if possible.

1625. Then any interruption to the flood must lessen the scour, and, consequently, do injury?—Undoubtedly.

1626. (*Capt. Beaufort.*) For what number of years do you know that the point of the Middle Bank has not come lower down the river?—I have known it since 1832, and I do not think it has moved since 1832.

1627. (Mr. *Hume.*) Do any of the sands below that, near the mouth of the river, shift?—They are shifting constantly.

1628. Do you mean without the bar or within the bar?—Just at the bar; the Seaman's Fraternity are always moving their buoys.

1629. You have not turned your attention to the bars outside so much as the harbour inside?—No.

1630. Is it your opinion that all these dykes and encroachments which you have pointed out on the river above the town should be removed in order to improve the navigation?—I would not go so far as to say they ought all to be swept away, because some of them are taking in ground which is already silted up almost to high water; and though in principle the smallest encroachment is bad, still I think the injury done may be extremely trifling.

1631. In principle you think every encroachment ought to be avoided?—Certainly. Sometimes you may encroach a little with advantage, because you may straighten the shore, and do more good by the straightening than by the abstraction of the water.

1632. By directing the current?—Yes; and I have recommended that to the Dundee Harbour Trustees. The proposed Perth Railway comes above the harbour; some persons objected to it because it abstracted water. I said to them, "Any injury done by that will be more than compensated by the good which will be done from straightening the channel."

1633. Strictly speaking, ought not compensation to be given by cutting away some projecting part of the bank, so as to admit the same quantity of water while you straighten the stream?—That would be a double compensation. I do not know whether they are bound to do it; but it was talked of. They were to be bound to cut away the point of rock at the Magdalen yard, which I recommended two years ago.

1634. As engineer to the Harbour Commissioners, are there any improvements or any measures that you would recommend, calculated to improve the harbour beyond those you have now suggested?—There are certain rocks that ought to be blown away.

1635. You would recommend the removal of all rocks?—Yes, as far as our funds would admit of it. I have been called upon to give a plan for a low water pier at the Beacon Rock, or on the outer wall, and I have recommended one to be built, a timber one, projecting out from the outer wall.

1636. Is there not a tendency of the silt to deposit at the rocks?—Yes, the silt deposits to some extent in the line of the rock.

1637. Do you think the removal of the rocks would sweep that away?—It would be a great advantage; but the expense would be so enormous, that I never thought of proposing that. Unless you take the rock down to a considerable depth, it will be more injurious; if you took it down just to low water, it would be more dangerous than it is now.

1638. (*Capt. Washington.*) Are not the Fowler, Beacon, and Drummond Rocks, lying just at the entrance of the basin, prejudicial to the harbour, not only in point of navigation, but as forming a slack on the flood tide, and thereby causing a deposit of silt?—Yes, it would be a great advantage to have them removed.

1639. Are you aware of any very great freshes in the river Tay during the last ten years that can have caused an increased depth of ten feet of water at the entrance, as you will find by the Admiralty survey of last September?—I do not think there has been a fresh in the Tay that

could affect the bars materially; I think that any effect from a fresh at the bar is a mere bagatelle compared with the scouring of tidal water.

1640. Then are you not of opinion that the increase of depth at the entrance of the river may be fairly attributed to the dredging above Newburgh, and the removing 840,000 tons of soil from its bed?—No; I do not think that any works in the upper part of the Tay could have had any such effect.

1641. Has not the removal of that quantity of soil admitted fully one million cubic yards more of water on every tide since its removal?—I do not know that it has admitted any water, because most of it is put into the side to narrow the river.

1642. (Mr. *Hume.*) Has it been laid within high water mark?—Yes; Messrs. Stevenson's plan is to narrow the river to one deep channel, in the same way as they have been doing in the Clyde. In one place, where there was an island in the middle, they shut up the channel. I have no doubt that more water goes up now than formerly, but not to the extent of the soil that has been lifted, because a good deal of what was lifted was put down below high water mark.

1643. Then, all that is lifted from the bed ought to have been laid outside the high-water mark?—I do not say that, because it may be very beneficial to narrow and straighten the channel.

1644. (*Capt. Washington.*) From your experience as resident engineer at Dundee, are you of opinion that it would be desirable to have a public Board, such as an Harbour Board in connexion with the Admiralty generally, to superintend harbour affairs?—If that Board was to look after encroachments and the general interest of the public harbours in the kingdom, I think it would decidedly be beneficial.

1645. (Mr. *Hume.*) Have you ever entertained opinions respecting encroachments of the river different from what you now entertain?—No; I never have since I considered the matter at all.

1646. Have you given in any plans for harbours that would have shut out the tidal waters to a considerable extent?—Not to a considerable extent. There was a design for a very small harbour for Mr. Allen, of Errol, which I gave about 12 years ago. The principle of that was bad, in so far that it would have excluded some water, not directly, but by its ulterior affects in silting up the shore.

1647. In the other harbours in Scotland where you have been consulted, have your opinions been such as you have now stated, that every impediment ought to be removed, and the tidal water admitted as far as possible?—Certainly; but it must be understood that the docks of Dundee have been an encroachment on the river; they are taken from the river.

1648. Were they not rather in a bight of the river?—Rather so; we have no other place to put them, as there is only a very narrow strip of level ground at Dundee, between a ridge of hills and the sea, and this is all covered with buildings, which would be very expensive to purchase.

1648*a*. (*Chairman.*) What tidal rivers and harbours have you examined and reported upon?—Leith Harbour, Dundee Harbour and River Tay, River Earn, Montrose Harbour and River South Esk, Arbroath Harbour, Inverness Harbour and River Ness, Nairn Harbour and River, Kirkaldy Harbour, Burghead Harbour, St. David's Harbour, Warkworth Coquet Harbour, &c., &c.

1648*b*. In the course of your experience, have you been enabled to lay down any principle which is generally applicable to the improvement of tidal rivers?—No; circumstances vary so much, that a principle which may be advantageously applied to the improvement of one river may not be at all applicable to another.

1648*c*. What are the chief obstructions to the propagation of the tide which are generally found to exist?—Straits, sinuosities, and fords or shoals.

1648*d*. Explain in what way these obstructions operate?—A strait acts like the narrow neck of a bottle, and sometimes prevents the river or estuary above it from filling or emptying so as to acquire the level of the ocean either at high or low water, as in the case of Old London Bridge.

Sinuosities cause the tidal wave to expend its force in striking against the concave side, and shoals or fords act generally in a similar way to a strait, although the tide may, to some extent, overcome the obstruction so formed, by rising up to a higher level over them.

1648*e*. How can such obstructions be most effectually removed?—When the sides of a strait consist of rock, as at Broughty Ferry in the Tay, or at Seacombe in the Mersey, it is difficult and may be impossible to widen it or to remove the obstruction, and the only thing that can be done in such a case is to prevent an aggravation of the evil by any farther encroachment; and if the projecting point cannot be cut away, it may sometimes be made less an obstruction by giving a good curve to the line of shore, so as to make the contraction gradual and like a trumpet mouth on both sides, instead of being abrupt.

Sinuosities may generally be removed by dredging off salient points and filling up bays: fords or shoals generally by dredging, if the bottom be gravel; but they may require to be removed by diving-bells, coffer-dams, or by temporarily changing the channel of river, if the bottom be rock; and if the bottom be sand or mud, it may frequently be removed by properly directing the scour of the river itself: but this may be prejudicial unless there is a strong tidal current across the mouth of the river or harbour, as otherwise the mud or sand carried down by the river would be likely to deposit at the mouth and to form a bar.

1648*f*. Are you of opinion that depths in rivers and their powers of scouring are chiefly due to the volume of water brought down in freshes, or to tidal waters?—At the mouth of the river to the tide, but gradually getting less so, and more due to the river as you ascend, until the action of the tide finally ceases.

The action of the tide at the river mouth is still more preponderating when the river widens

Mr. *J. Leslie.*
May 30, 1845.

out into an estuary, and this, I think, is always the most favourable condition for keeping the bar of a river clear.

1648*g*. Is there more to fear for our river harbours from the detritus brought down by the stream, or to silt carried into them from the sea?—That depends on the nature of the river, and of the position of the harbour or river mouth. A river, such as the Ness, which is the outlet of a large lake, brings down little or no detritus, as that has been all deposited in the lake, but generally, in my opinion, there is more deposit in river harbours from the river than from the sea. Rivers which take their rise in mountainous districts generally bring down large quantities of gravel, and those which flow through flat alluvial countries a great deal of mud, and frequently these conditions are blended, and gravel, sand, and mud are all brought down together. A river which empties on a shore which is constantly being undermined and washed away by the action of the sea, such as a chalk cliff, is more liable to be obstructed by the shingle brought by the sea than by its own detritus.

1648*h*. Can you state any instances in which works designed in conformity with the principle you have laid down have been productive of beneficial effects?—The Clyde, the Tay, and many other rivers, have been materially improved and deepened by the proper application of dredging and straightening their channels.

1648*i*. Can you furnish the Commission with any data as to the cost of dredging harbours or rivers?—At Dundee, dredging mud or sand, and heaving it up and running it along railways to embank ground, costs 7*d*. to 7½*d*. a cubic yard, including a per centage on the dredging machinery. When the stuff is dropt from hopper punts, which is done until the ground gets too high for the punts to float over it, the cost is 1*d*. or 1½*d* per cubic yard less. I could state the prices of dredging at other places, some more and some less than at Dundee, but not of my own knowledge.

1648*j*. Are you of opinion that it would be beneficial to have a Central Harbour Board established in London in connection with the Admiralty, that should have a general supervision and control over the improvement and management of all harbours of the United Kingdom?—Yes. I am of opinion that it would be highly beneficial to have a central board of supervision and control over harbours to prevent obstructions and encroachments, &c., because such a board would generally be competent to decide at once whether any projected work was objectionable or not, and so save expense of litigation; whereas the ordinary courts, when a complaint is made to them, can only be guided by the opinions of engineers or other competent persons to whom they must remit the question.

Wednesday, June 4th, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Capt. Sir GORDON BREMER, K.C.B.	Capt. BEAUFORT, R.N.
Mr. HUME, M.P.	Mr. A. CHAPMAN, M.P.
Mr. GODSON, M.P.	Capt. WASHINGTON, R.N.

Mr. *Adam Burnes* sworn and examined.

Mr. *Adam Burnes.*
June 4, 1845.

[*Plans and Sections of the embanked Lands near Old Montrose, by Messrs. Blackadder and Rendel,* 1842, *and Mr. G. Buchanan, C.E.,* 1843, *were laid on the Table.*]

1649. (*Chairman.*) What is your profession?—I am a solicitor and clerk to the trustees of Montrose Harbour.

1650. You reside at Montrose?—Yes.

1651. Are you acquainted with the state of the suit which is pending between the trustees of Montrose Harbour and Sir James Carnegie?—I am.

1652. Will you state to the Commission the present position of that suit?—In June, 1837, an Act was passed for the improvement of the harbour of Montrose, and vesting the management in trustees; it was formerly in the hands of the corporation, who did not pay sufficient attention to matters relating exclusively to the harbour. That Act was passed in 1837, but the trustees were not enabled until 1839 to proceed with their works. In that year the Wet Dock was commenced; the plans were submitted to Mr. James Walker, of London, civil engineer, who approved of the plans generally, and of his own accord suggested to the trustees to be very vigilant in preventing encroachments on the estuary or bason of Montrose, which he described as "the lungs of the harbour." In September, 1841, Sir James Carnegie, of South Esk, commenced an embankment on the estuary for the purpose of diverting the channel of the river of South Esk. A committee of the trustees met at the embankment with Mr. Lyall, Sir James Carnegie's factor or agent, at which I was present. Mr. Lyall explained that the object of the embankment was to divert the channel of the river. The committee did not object to the wall. The minute was as follows:—"The committee, after consulting Mr. Leslie, are of opinion that the present operations are not in themselves objectionable, but that any encroachments made to gain ground from the basin ought to be resisted, and that it is therefore proper to watch the proceedings of Sir James Carnegie."

1653. (*Mr. Hume.*) Was this an intimation to Sir James Carnegie against any encroachment on the land?—Yes; and the committee requested Mr. Leslie to prepare a plan, showing the proposed new channel of the South Esk, for the information of the trustees.

1654. Did he submit that plan?—He did.

1655. Did he point out that any encroachments would be injurious to the navigation?—He pointed out that that part of it for diverting the channel would not be injurious. In June, 1842, information was sent to me when I was in Edinburgh, that Sir James Carnegie was rapidly extending the embankment to the southern shore, so as to enclose and gain ground from the estuary. I instantly remonstrated, by letter, with Mr. Lyall; and upon my return to Montrose I personally attended at Kinnaird Castle, the residence of Sir James Carnegie, and intimated a notarial protest against his proceedings, by order of the trustees.

1656. Is that the usual mode of public bodies, intimating their opposition to any proceeding?—It is. The party is warned that he proceeds at his highest peril. Simultaneously the trustees applied to the Lord Ordinary at the Court of Session in Edinburgh, for an injunction or interdict against this proceeding. That interdict or injunction was obtained about the 28th of June, 1842; and on the following day a special messenger intimated the interdict to Sir James Carnegie. The works were, notwithstanding, rapidly completed.

1657. What has been the effect of those works on the tidal lands?—The effect has been in the meantime to enclose about 62 acres of ground, and to exclude a very large quantity of water. The trustees at the same moment memorialised the Admiralty, and the Secretary (the Honourable Sidney Herbert) desired me to suggest to the trustees to consult an engineer of eminence, and particularly pointed out Mr. Rendel, who was then in Dundee, about some works on the part of Government. Mr. Rendel accordingly inspected the works in the presence of Mr. Leslie (the harbour trustees' engineer), Mr. Blackadder (Sir James Carnegie's engineer), and myself; and he afterwards required the two engineers to concur in a statement of facts and to subscribe a plan. This is a sketch of the plan which the two engineers submitted to Mr. Rendel, at his request. (*Plan laid on the table.*)

1658. Was that sketch of the embankment last enclosed by Sir James Carnegie agreed upon as to its limits by the two engineers?—It was. Mr. Rendel did not frame his report until the month of December. He transmitted it in duplicate to the Admiralty and myself as for the harbour trustees. In that report he stated that the complaint of the harbour trustees was well founded; but he recommended that the embankments should be allowed to remain, provided Sir James Carnegie adopted the alternative of making certain excavations higher up the river, on purpose to allow a greater quantity of water to come up, and in some measure to compensate for that excluded by the embankment. After obtaining the sanction of the Admiralty to this arrangement, I, on the part of the trustees, and as authorised by them, addressed a letter to Sir James Carnegie, dated 20th December, 1843, and requested him to state, within a certain number of days, whether he was prepared to adopt the course pointed out by Mr. Rendel, and sanctioned by the Admiralty, which letter was acknowledged on the 21st of December, 1842.—(*For the Letters, see Appendix.*)

1659. (*Capt. Sir G. Bremer.*) Did you make any further application?—Sir James Carnegie not having given any answer, the interdict proceeded to be heard in the court of session.

1660. (Mr. *Hume.*) It has been stated by the Lord Advocate, than an injunction was obtained. Were you present, or can you state the nature of that injunction?—Lord Fullerton, the Lord Ordinary, who decided the case, held that the embankment had proceeded so far, that that form of procedure—injunction, which is a summary one, was not suitable to the case, and therefore that it required to be tried in a more formal manner, the merits were entirely reserved, and there was no opinion given on the merits of the case. These are the words of Lord Fullerton—"The embankments complained of are already completed, with the exception of certain works intended only to protect them from external injury." Sir James Carnegie offered security to meet any damage that should occur.

1661. Was that security granted?—It was not; Sir James Carnegie was ready to grant it; and if it has been stated it was granted, it was stated on my authority, for I understood it to be granted from the correspondence.

1662. Were there any other legal proceedings after that?—No other legal proceedings have since been taken by the trustees. A good deal of correspondence passed with a view to induce the Admiralty to take up the case.

1663. Why did you apply to the Admiralty to take up your case?—Because the Wet Docks had been just completed at a great expense, and the money raised upon the personal guarantee of a number of gentlemen, who derive no pecuniary benefit, and we have not the means of prosecuting proceedings in a court of law.

1664. Was any memorial forwarded to the Admiralty, and what was their answer?—A memorial was forwarded to the Admiralty, and the Admiralty directed Mr. Robson, Admiralty solicitor, to inquire into the circumstances, and after that, the matter was remitted to the Lord Advocate to report upon it.

1665. Have you any knowledge of the reports of Mr. Blackadder and Mr. Buchanan?—Mr. Blackadder concurred in a joint statement of facts with Mr. Leslie to Mr. Rendel, and signed the plan which Mr. Rendel proposed, after which Mr. Rendel framed the plan which accompanied his report to the Trustees and the Admiralty.

1666. Did he give any report as to the injurious tendency of enclosing the tidal water in the harbour?—Mr. Blackadder's report as to that was not asked; Mr. Rendel merely wished him to concur in the facts upon which he was to form an opinion.

1667. Now with respect to Mr. Buchanan, are you aware what his report was?—Mr. Buchanan was employed by Sir James Carnegie latterly, and I believe gave an opinion that it was not injurious to the harbour.

1668. Can you state of your own knowledge, that during the time you have acted as clerk to the Montrose Harbour Commissioners, they have throughout been anxious to guard against any encroachment on any portion of the basin or harbour covered by tidal water?—They have

Mr. *Adam Burnes.*

June 4, 1845.

been most anxious; in fact, a small quantity of mud was lately put down by the Bridge Commissioners, and the Harbour Trustees resisted it, and ordered its removal.

1669. Do you know whether the Commissioners would have prosecuted their suit against Sir James Carnegie, so far as to compel him to remove these encroachments if they had had funds at their disposal so to do?—I am certain they would.

1670. And it is only from their funds being engaged in finishing the works, and even money borrowed on the private credit of individuals, that they were prevented from going on?—It is. They have expended about 42,000*l.* within the last few years for completing the works; these are not the property of any joint stock company, where individuals can derive profit, but a public harbour of which they are mere trustees, and from which they derive no pecuniary benefit.

1671. What are the revenues arising to the Harbour Commissioners from their charges?—About 3,400*l.* a year; they have averaged that amount since May, 1839.

1672. How much of that is applied towards the payment of money borrowed?—The amount of debt is about 40,000*l.*, and the interest is about 3½ per cent.

1673. Did you not apply lately to the Treasury to obtain from the Exchequer Bill Commissioners a reduction of the amount of interest to that which they paid, with the view of assisting you in your proceedings?—The trustees applied lately to the Treasury to authorize the reduction of the rate of interest. The Treasury replied they could not do it, but agreed to authorize the assignment of the mortgage they hold to another party. The trustees applied to various banking establishments, and the money was offered for two years at 3 per cent.

1674. Have you any further observations to make respecting the state of the harbour?—I would add, that I believe the harbour would be very much improved if what is called the Stone adjoining Scurdy ness, on the south side of the entrance to the eastward were removed.

1675. (*Capt. Washington.*) Until the Stone can be removed, would not a good beacon be very serviceable?—Most undoubtedly it would; and Mr. Walker, the engineer, suggested that to the trustees.

1676. Why have not the trustees erected that beacon?—Because their funds are quite inadequate.

1677. Is not such a beacon quite within the business of the Commissioners of Northern Lights?—I believe so.

1678. Is not the North Carr Beacon off Fifeness erected by the Commissioners of Northern Lights?—I believe so.

1679. (*Mr. Hume.*) Are you able to state whether any encroachments have been made upon the tidal waters of Montrose Basin, or the neighbourhood, by Sir James Carnegie's predecessors?—Yes, and they are correctly shown on the plan.

1680. To what extent, and in what years?—There was an embankment made in 1817, one in 1830, and a third in 1831.

1681. What is the number of acres?—I should think at least 60 acres each. I beg to give in a tracing of a plan drawn by Mr. Buchanan, dated in 1843, he being Sir James Carnegie's engineer, with all the depths marked upon it.

[*The Witness withdrew.*]

Mr. *D. Stevenson.*

June 4, 1845.

Mr. *David Stevenson*, F.R.S. Edin., Civil Engineer, sworn and examined.

[*Mr. Stevenson's large plans and sections of the Tay, the Forth, Dornoch Frith, the Ribble, the Lune, and the Dee, &c., were exhibited.*]

1682. (*Chairman.*) What is your profession and place of residence?—Civil engineer, residing in Edinburgh.

1683. How long have you been acting as a civil engineer?—About eight years, in partnership with my father and brother; and before that I was about three or four years acting as a resident engineer.

1684. What tidal rivers and harbours have you examined, and reported upon?—I have surveyed and reported on the Dee, in Cheshire; the Ribble, Lune, and Wyre, in Lancashire; the Trent and Fossdyke, in Lincolnshire; the Earne, in Ireland; and the Tay and Forth, in Scotland. I have designed and executed extensive works on some of these rivers. I have also designed and executed various harbour works in Scotland and Ireland, and have had occasion to survey in the course of my professional employment several of the Firths and Bays of Scotland.

1685. In the course of your experience, have you been able to lay down any principle which is generally applicable to the improvement of tidal rivers?—I have; the rivers in this country are comparatively small, and their waters can only be navigated when under the influence of the tide. They may, therefore, be said to be small creeks kept open by the joint action of the fresh-water stream and the tidal influence. The fresh-water stream cannot be materially increased by any work of art; and therefore my opinion is, that the principle that should be kept in view in improving such navigations is to *increase the duration of the tidal influence,* by removing obstructions to the progress of the tide along the river's bed and banks.

1686. What are the obstructions which are generally found to exist?—The causes which are most frequently found to operate in producing retardations in the propagation of the tide are the circuitous routes of the channels of rivers; the projection of obstacles into the stream, such as jetties, &c.; the erection of weirs, and especially the slope of the river's bed, and the downward flow of the fresh water occasioned by it.

1687. Can you explain in what way these obstructions operate?—When the tidal wave

enters a river its velocity is modified by the obstruction it receives, and in all cases with which I am acquainted the rise of the tide in the lower parts of the river is more rapid than its propagation, so that the water becomes heaped up in the lower parts of the river and acquires a much higher level than the water in the upper part of the river; or, in other words, at low-water there is a slope from the sea *upwards*, but at other periods of tide there is a slope from the sea *downwards*, caused by the obstruction to the propagation of the tidal wave and the consequent heaping up of the water. Thus, in the Dee for example, there is, at low-water, a fall of 11 feet from Chester to Flint; but on one occasion I found that although the tide had risen 18 feet 10 inches at Flint it had not commenced to rise at Chester, and at the time alluded to the level of the water at Chester was 7 feet 10 inches *below* that at Flint, which is situated 12 miles further seaward. The more rapid the tide and the greater the rise, the more clearly is the obstruction to the tidal wave exemplified, as shown by the following spring and neap tides taken from the Lune and Dee.

River Dee, Cheshire.			River Lune, Lancashire.		
Date.	Rise of Tide at Flint.	Maximum Fall from Flint to Chester.	Date.	Rise of Tide at Glasson.	Maximum Fall from Glasson to Lancaster.
1839.	Ft. In.	Ft. In.	1838.	Ft. In.	Ft. In.
May 21 . .	14 0	3 8	August 29 .	12 1	1 1
May 23 . .	15 6	4 5	August 31 .	12 9	1 6
May 25 . .	16 4	5 8	September 1 .	15 4	2 0
May 29 . .	18 0	6 6	September 3 .	19 8	2 10
June 10 . .	19 8	7 10	September 5 .	23 2	3 2
			September 6 .	23 6	4 4

1688. How can such obstructions be most effectually removed?—The obstructions are various, and the means to be employed depend on their nature. If there are impediments in the beds they can be removed, either by dredging, if the material is such as can be dredged, or by excavation, by means of coffer-dams, if it is of a harder nature. If the obstruction consists of projections from the banks of the river, these may generally be removed by very simple means, and the low-water channel may often be advantageously directed by means of low walls. As a general rule it may be stated, that the obstructions to the tidal wave may be removed by reducing the slope of the bed of the river, and all these works have a tendency to effect this.

1689. Have you already been concerned in removing obstructions of this nature in rivers you have been employed on?—Yes, pretty generally; on the Tay and on the Ribble, in particular, I have removed many such obstructions.

1690. Can you furnish the Commission with any data as to the cost of dredging?—From 5*d.* to 6*d.* per cubic yard is a fair price for dredging gravel, including all expenses.

1691. Are you of opinion that depths in rivers and their power of scouring are chiefly due to the volume of water brought down in freshes, or to the tidal waters?—I should say to the tidal waters.

1692. Which is most to be feared in our tidal rivers, the detritus brought down by the stream, or carried into them from the sea?—Something must depend on the situation; but in general I should say, so far as my experience goes, that the detritus brought down by the fresh water is more to be feared.

1693. (*Capt. Beaufort.*) Does that observation apply principally to the east or the west coast?—It is general and refers to the courses of tidal rivers, not to bars; not, for example, to the bar of the Mersey or the bar of the Tay.

1694. (*Chairman.*) Can you state any instances in which works designed in conformity with the principle you have laid down have been productive of beneficial effects?—Yes, the Tay and Ribble are both examples of it. The state of the Tay navigation before the operations were commenced was as follows. At low water the depth was about 1 foot 9 inches, and at high water about 11 feet 9 inches on several fords or shoals, which existed between Perth and Newburgh, namely, Kirwhinnel, Seggieden, Millhurst, Sleepless. These different fords were deepened by means of dredging, and three islands at the three upper fords were connected to the shore by means of embankments. Besides that, a great many boulder stones were removed from the bed of the river, some of them 50 tons weight, and in some places the banks were cut, so as to widen the river. The present depth is about 5 feet at low water, and 15 feet at high water.

1695. (Mr. *Hume.*) Is not every embankment calculated to exclude the flow of the water?—No; in this particular situation I conceive it was not; at each of those islands a *ford* or shallow was formed from the currents being diverted by these islands; and in order to maintain a proper navigable depth, as well as to clear away those fords, to enable the tidal wave to be propagated up the river with sufficient speed, and a greater body of tidal water to be admitted, we found it necessary to divert the whole of the currents, both of the flood and ebb tide into the main channel of the river, by means of the embankments.

1696. Do you by that means lose any surface that otherwise would have been covered by tidal water?—We have not yet lost any surface, excepting that occupied by the embankment; but at the back of these islands the process of silting is going on.

1697. Can you give any compensation by deepening elsewhere, so as to continue or increase the volume of tide?—I think we have already, by our operations, given ample compensation for what has been or will be shut out by these embankments.

1698. Have you obtained a straighter current, and a deeper channel?—Certainly.

1699. (*Chairman.*) Will you state the present tidal phenomena as compared with those

Mr. *D. Stevenson.*
June 4, 1845.

before the operations were commenced?—The fall on the bed of the river from Perth to Newburgh, before the operations commenced was four feet, and now that fall is only two feet. The passage of the tidal waters from Newburgh to Perth, in 1833, a distance of 8·56 miles occupied two hours and thirty minutes, being at the rate of 3·42 miles per hour; but it is now propagated between the same places in one hour and forty minutes, being at the rate of 5·13 miles per hour; giving a decrease in the time of fifty minutes, and an increase in the speed of the first wave of flood of more than 1¾ mile per hour since the operations commenced.

1700. By whom were these observations made, and when?—They were made partly by myself and partly by assistants under my direction. They have been made at various times since 1833, and we have found a gradual improvement in the tidal phenomena; and the last result which I have just stated was obtained from observations made in 1844.

1701. Have these tidal phenomena been apparent, and increased in proportion as you increased your operations and removed the difficulty?—I think so.

1702. Have you any doubt these phenomena and changes have arisen from the operations you have carried on?—Not the least whatever. As a further proof of the change which has taken place, I may state that in 1833 the spring tides at Perth flowed for two hours and twenty minutes, and ebbed for seven hours; and at low water the river ran at its natural level for one hour and forty-five minutes; but now the tide flows three hours and ten minutes, ebbs seven hours, and stands at low water only one hour, being an increase in the duration of flood of 50 minutes, and a decrease in the time at which the river is uninfluenced by the tide of 45 minutes.

1703. How do you account for that change?—Formerly, as I stated, the tide occupied two hours and thirty minutes in ascending from Newburgh to Perth. The flood at present arrives at Newburgh at the same time as it did before, but it arrives at Perth 50 minutes sooner; so that the length of time during which the tide is actually rising at Perth is increased, and the length of time during which it is falling is nearly the same, the river running in its natural state a proportionally shorter length of time. The difference between the termination of the ebb and the beginning of the flood is lessened by 45 minutes.

1704. How do you explain that?—It is occasioned by the low water level being lowered at Perth, which causes the flood to come more rapidly from Newburgh to Perth than formerly, so that it begins to rise sooner than it did before.

1705. Is that caused by the deepening and removal of the obstructions which formerly existed?—Entirely. I would add, as a still further proof of beneficial change, that from calculations which I have made, I find that an additional quantity of tidal water, amounting to at least a million of cubic yards, passes every tide above Newburgh.

1706. How have you ascertained that?—By a calculation founded on the present section of the low water line of the river compared with the former section in 1833.

1707. Does that section run through the whole distance between Newburgh and Perth that increases in the volume?—It is an increase due to the whole space between Perth and Newburgh.

1708. (Mr. *A. Chapman.*) Does the tide rise higher than it did at Newburgh and at Perth?—No; the level of the high water is much the same at these points, but it sinks lower, owing to the bed of the river having been lowered, and therefore there is an additional range of tide.

1709. (*Chairman.*) What was the former state of the Tay navigation as to shipping coming up to Perth?—Formerly vessels generally unloaded part of their cargo at Newburgh, and even with that they were sometimes two spring-tides in getting up to Perth on account of the obstructions, unless they were fortunate in their tides. Now, vessels of the same class come up with perfect ease in one tide to Perth from Dundee without unloading.

1710. Do you consider the Tay capable of further improvement?—I do. I conceive that the Tay, by judiciously laid out works, could be easily deepened to 18 or 20 feet at high-water spring tides up to Perth. The average slope of the bed from Perth to Balmbreich is still upwards of 5 inches per mile.

1711. Will you state what the nature of those proposed works would be, and in what part of the river they would be carried on?—The works proposed consist of dredging in the upper part of the river from Perth to Newburgh, and in the erection of a low rubble wall from Newburgh downwards to a point, probably at Flisk, a distance of about 6 miles. The estimated cost is between 45,000*l.* and 50,000*l.*

1712. (Mr. *Hume.*) What height of wall?—It might be made as high as high-water mark without prejudicing the navigation, but it would not be necessary to make it that height.

1713. What purpose do you expect to answer by that?—We expect to be able to regulate the channel from Newburgh to Flisk, which at present is very much distorted and unequal in depth, chiefly on account of certain jetties which have been projected from the shore, and also to reduce the slope from Newburgh downwards (which is at present about 10 inches per mile,) and thus cause a further acceleration of the tide between Dundee and Perth.

1714. Are these jetties by the proprietors on the shore an encroachment on the water?—They are.

1715. Do you consider you have the power of removing them now?—We have by a late decision of the Court of Session.

1716. For what expense can that be done?—The proprietor is obliged to remove them. The estimate I do not know.

1717. Have any notices been given to the parties who erected the jetties to remove them?—Yes, and they are now in the process of being removed.

1718. After those removals, you would erect the rubble wall, which you have stated?—Yes.

1719. Do you expect by straightening the course to increase the current, and thus deepen the channel along the wall?—Yes, I expect to equalize the current, to get deeper water, and to facilitate the flow of the tide.

1720. Do you contemplate dredging to remove those banks which now appear to occupy the southern part of the channel?—No; but it may be necessary to dredge in front of the wall which we propose to erect, in order to remove the fore-shore.

1721. What width do you propose to deepen that channel beyond the wall running in the line you pointed out?—We do not contemplate much dredging or much widening between Newburgh and Flisk Point, only such as is necessary to remove any hard obstructions which cannot be removed by the current of the tide.

1722. Would that give you the 4 feet addition in the upper part of the river?—These operations, in connexion with the works proposed in the upper part of the river, would do so, and would also increase the velocity of the tidal wave up to Perth, and the influx of tidal water.

1723. Have you any other contemplated improvements?—No.

1724. What is the depth of water from Flisk downwards for vessels in ordinary tides?—In no place less than 30 feet at high-water spring-tides between Flisk and Invergowrie; below that, the Firth is from 6 to 9 fathoms at high water.

1725. If that improvement was made, would the River Tay be navigable to Perth, by vessels drawing 18 feet, and thus render the unloading the cargo at Newburgh or any other place unnecessary?—Certainly; and in addition to the greater depth the shipping would have the advantages produced by the increased duration of tidal influence, which in proportion to its amount, prolongs the period during which the navigation is available for the passage of shipping, and thus tends directly to improve it.

1726. Have you found in your intercourse with the river any difficulty in persuading the proprietors to remove encroachments in the river?—Yes; and it has only been by constant appeals on the part of the Conservators of the River and Navigation Commissioners to the Courts that they have been enabled to prevent encroachments. The law process connected with the removal of these jetties was very tedious and expensive.

1727. Is it understood that the last decision to which you alluded has settled the law as regards the encroachments generally on the Tay?—I do not know that there is to be any appeal from the Court, but of course there may be an appeal to the House of Lords.

1728. Would you, as an engineer, recommend the removal of all obstructions by way of jetties, or otherwise, that you consider to be an impediment to the navigation?—Certainly.

1729. (*Capt. Sir G. Bremer.*) I think you have said that these obstructions are in process of removal, in consequence of the decision of the Court?—Yes.

1730. (Mr. *Godson.*) Have these decisions enabled you to remove any that have been erected more than 20 years?—I think not.

1731. Are you sure that you can remove any which are supposed to have been erected 40 years?—No; I suspect not.

1732. Then the result is, as far as your impression goes, that all that have been removed by order of the Court have been erected within 20 years?—I believe that is the state of things.

1733. (*Capt. Washington.*) Under whose superintendence or control is the buoyage of the Tay from the lower limits of the Perth Commissioners upwards?—Under the magistrates of Perth, as Conservators of the river.

1734. Are there sufficient buoys for the safe navigation of the river?—I have not heard any complaints.

1735. Do you think that the embankment directing the current you have proposed might tend slightly to carry away the lower end of the Middle Bank that lies so inconveniently between Dundee and Newport?—The embankment in itself would not, I think, if it stopped at Flisk; but if the result of the embankment is, as I anticipate, to get a still greater amount of tidal water into the estuary, then, of course, that would have some effect on the bank as a scour.

1736. Do you know what is the nature of the Middle Bank; is it gravel, or sand, or mud?—I think sand.

1737. (*Capt. Sir G. Bremer.*) Have you ever contemplated the extension of the embankment you mentioned, as far as Balmerino?—No.

1738. Supposing it were continued as far as Balmerino, would not that have a considerable effect on the Middle Bank?—It would.

1739. Would you consider that a judicious measure?—No; it would tend to withdraw the water too much from Dundee. I think it would not be judicious, because the channel below Flisk is sufficient for all the purposes of the navigation.

1740. (*Chairman.*) What was the former state of the river Ribble?—Spring tides rose about six feet at Preston, and tides of 14 feet rise at Liverpool, did not rise at Preston at all. The depth of the navigation at high water of spring tides was only for vessels drawing about six feet. The vessels employed were lighters or flats, which got the cargoes from the vessels frequenting the port, at Lytham.

1741. What works have been executed, and what is the present depth and state of the tides?—About 30,000 cubic yards of rock have been excavated near Preston; about 800,000 tons of gravel have been dredged, and 7½ miles of low rubble walling have been erected in the lower part of the river, from a place called the Chain downwards. Those are all the works which have been executed hitherto; the dredging and walling are at present in progress, and the improvements effected of course are progressing also. I cannot state so definitely as I was able to do with regard to the Tay, the exact amount of improvement, but vessels of about 12 and 13 feet draught go up to Preston, which was formerly reached only by flats drawing 6 feet. The vertical range of the tide at Preston has been increased about 4 feet. I may state further to show the practical effect of the improvements that previous to 1840, as I mentioned before, the vessels were unloaded in the lower part of the river, and the goods brought up by lighters. In the first three months of that year (1840), no vessels, excepting flats, came

Mr. *D. Stevenson.*
June 4, 1845.

up to Preston; in the first three months of 1841, 23 sailing vessels came up to the quays; in 1842, 37 vessels came up; in 1843, 61 vessels came up; in 1844, 66 vessels came up, and during the first three months of this year, 95 vessels have come up. These numbers I have received from Mr. Park, who conducted the greater part of the works as resident engineer. The dues have been nearly quadrupled since the commencement of the works.

1742. Are there any vessels that now unload a portion of their cargo at Lytham, as formerly?—Yes; the largest class of vessels that frequent the river, I believe, unload there.

1743. Do you know what proportion of the trade is so landed?—No.

1744. Do you know what is the tonnage of the largest vessels that can go up to Preston?—About 200 tons. I suppose the draft may be stated at 12 or 13 feet.

1745. Is the river susceptible of further improvement?—I think so by the continuation of the different operations at present going on. The rock excavation was carried to such a depth as to admit of the river being deepened to 20 feet. The excavation was done by cofferdams of peculiar construction which I designed for the especial purpose. I think, it could be deepened to the extent of from 18 to 20 feet up to Preston. In order to do that, it would be necessary to carry the excavation a little above Preston. There is rock in the upper part of the river above Preston, and we should excavate that, in order to give the tide a freer run up the river.

1746. (Mr. *Hume.*) How high above Preston does the tide flow at present?—About four miles and a half, or 21½ from the Irish Sea.

1747. Would the removal of the obstruction which you have now mentioned enable it to go further?—I think it would.

1748. And thus increase the volume of water for the downscour?—Yes.

1749. What expense has been incurred in doing the works you have now stated?—The whole works have cost, I think, about 47,000*l.*

1750. Have you any estimate of the expense which would be required to obtain that increased depth of water?—I have made no estimate of what would be necessary, in order to carry the depth to 20 feet.

1751. Are you still employed as engineer?—Yes.

1752. Is there any bridge at Preston, and is that bridge any impediment to the water-way?—It is an impediment, but not a bar to the improvements which I have sketched out.

1753. (Mr. *Godson.*) Are there not more than two or three bridges?—There are three bridges.

1754. (Mr. *Hume.*) Are the Commission to understand that your future improvements will have in view the removal of all impediments, not only below, but above Preston, with a view of increasing the tidal flow to have the benefit of the downscour?—Certainly.

1755. (*Chairman.*) Can you name to the Commission any other rivers in which you think improvements can be effected by similar works?—The Lune, the Forth, the Trent, and the Dee.

1756. Have you made any separate report on the several rivers you have now mentioned?—I have made reports, and have all the details with reference to the tidal phenomena of these different rivers.

1757. Are they mentioned in the reports?—Not fully; the reports are general.

1758. (Mr. *Hume.*) Can you, if the Commission require it, give a short statement of the circumstances you think requisite to be known respecting those rivers?—I can.

1759. (*Chairman.*) Can you point out to the Commission any rivers in the United Kingdom the navigation of which has been injured by artificial obstructions, placed in order to gain land, or for any other purpose?—Yes; the Dee is an instance of that; a great quantity of land has been taken in, to the extent, I believe, of about 4000 acres, by means of an embankment upwards of 7 miles in length, the line of which has been most injudiciously laid out as regards the navigation. A weir has also been erected at Chester, which rises 11 feet 6 inches above the bed of the river, dams up the water for 6 or 7 miles, and checks the flow of the tide above the town. The Lune is another instance where land has been taken in, and where weirs also exist and check the flow of the tide. On the Wyre there are obstructions On the Ribble the existence of jetties was very prejudicial when we first surveyed it.

1760. Are you of opinion that it would be beneficial to have a central harbour board established in London, in connexion with the Admiralty, that should have a general supervision and control over the improvement and management of all harbours in the United Kingdom?—I think it would be very proper. I am not now prepared to enter into details as to the construction of such a supervising board; but I may state that I think it would be beneficial, because the rivers of the country may, in my opinion, be considered as so many public highways belonging to the public, stretching into the interior in various directions; and the interests of the landed proprietors are certainly quite hostile in most instances to the interests of the navigation.

1761. (Mr. *Hume.*) By the word "hostile," do you mean that they are disposed to encroach on land now covered by the water, and thus impede the general navigation?—Yes.

1762. Have you found a general disposition, on the part of landed proprietors, to attend to their own interests in that way, instead of taking a general view of the public interest?—In some cases I have: in the case of the Tay, for example.

1763. Do you consider that there ought to be in every Local Board a portion of the Commissioners uninfluenced by property, and having their authority from, or being appointed by, the Admiralty to watch the public interest?—It would be a very proper measure.

1764. Would not such a Board, established a century ago, have tended very much to prevent injuries that now have been produced by encroachments?—I think there is no doubt of it.

1765. And will the future benefit of the navigation generally be promoted by the establishment of some such supervising authority?—I think so.

1766. Do you consider the authority should be to know all improvements or alterations in harbours before they are commenced as a means of preventing evil, as now done, and only noticed after their consequences are seen?—Yes.

1767. Are there any other suggestions you can offer to the Board as a means of improving the navigation generally of tidal harbours?—No; I think such a supervision would answer all the ends in view.

1768. Are you acquainted with the embankment that has been begun by Sir John Richardson on the north side of the Tay, as stated in his letter to the Commission of the 28th of May?—I am, if the embankment referred to is that extending from Cairnie Pier downwards.

1769. Will you explain the nature of it?—Sir John Richardson was permitted by the Perth Harbour Commission to deposit materials on a line which was approved of by us (the engineers), for the purpose of directing the current more favourably down the south channel of the river, and also for the purpose of improving certain fishing-stations belonging to him which our works had destroyed, and for the produce of which the Commission was responsible by the Act of Parliament, by which they were bound to compensate for damages. I may state, that on account of the responsibility of the Commission for all damage done to fishings we had very great difficulty with different fishers on the river, and were glad to deposit the stuff for making up fishing-stations, which had been destroyed in places where probably we should not otherwise have done it.

1770. What is the nature of the embankment referred to in the letter, and what do you contemplate as the effect of that embankment?—I am not prepared at present to answer that question.

1771. (*Chairman.*) Have you surveyed the parts mentioned in the Memorial of the Commissioners of the Forth Navigation to the Lords of the Treasury on the 3rd June, from Stirling to Alloa?—Yes.

1772. Will you describe the river?—Between Alloa and Stirling there are seven fords: they consist for the most part of boulder-stones embedded in clay, and at present form great obstructions to the navigation by reducing the depth. The scheme which we pointed out was the deepening of these several fords, and in that way we propose to obtain a depth of 13 or 14 feet of water up to Stirling, which will be sufficient for the class of vessels that navigate the Forth. At present the depth is about 10 feet; we gain 3 feet. The uppermost ford is called the Town's Ford: it is 2500 feet in length, and we propose to deepen it to an average extent of 2 feet, which will give a depth of 13 feet at high-water ordinary spring tides. The next is called the Abbey Ford, which is 1400 feet in length, and we propose to deepen that also 2 feet, giving 13 feet at high water. The next is called the Sow Ford, which is 400 feet in length, and we propose to deepen it 1 foot, which will give 15 feet. The next is Manor Ford, which is 1500 feet long, and it is to be deepened 1 foot 6 inches, which will give 16 feet. The next is Bandeath Ford, which is 1500 feet long, and it is to be deepened 1 foot, giving 18 feet. The other is Cambus Ford, which is 2800 feet long, and is to be deepened 1 foot, giving 20 feet. The lowest is Throsk Ford, which is 350 feet in length, and it is to be deepened 1 foot 6 inches, which will give 22 feet. The depths to be gained will enable vessels to have sufficient water over the lower fords at $\frac{1}{2}$ or $\frac{3}{4}$ flood, and to reach Stirling in one tide.

1773. (Mr. *Hume.*) Have you estimated what will be the expense?—The total expenditure for the deepening of the fords is 9404*l.*

1774. Are you able to ascertain when these were formed, and by whom?—My own impression is that they are natural fords. Some of them may be artificial fords; but they are so numerous that they are not likely to be all artificial. My opinion is they are what is called whin dykes, many of which traverse the valley of the Forth.

1775. In your survey did you find on the banks of the rivers any embankments or encroachment of what was formerly land covered by the tide?—Alloa and Tillybody Islands are surrounded by embankments.

1776. What extent of land do they now form, gained by these enclosures?—A considerable extent, but I do not know precisely.

1777. Are the levels of the land on those two islands below the level of high water spring tides now?—I believe them to be so.

1778. Are there not in other parts of the river higher up many embankments, which have excluded the tidal waters?—There are.

1779. Could you estimate the amount of those enclosures between Alloa and Stirling?—Not without a special survey.

1780. Has any survey been made that you are acquainted with?—Not with that object in view.

1781. Have you seen any ancient map of the River Forth?—No; I should state that the Forth throughout its whole course, from Alloa to Stirling, flows through what is called a *carse*, consisting of low flat land. An enormous extent of land would be flooded were it not for these embankments.

1782. Have these embankments, in your opinion, greatly affected the flow of water to Stirling?—The tendency is to affect it; but they have been erected now so many years that I cannot say what was its former state.

1783. Do you know whether the depth of water at Stirling, at any former period, was more than it now is?—No.

1784. How high above Stirling does the water flow?—To the Cruive, which is about 4½ miles above Stirling.

1785. Is it impeded there by any dam or impediment?—It is impeded there by a natural barrier and a dam.

1786. For what purpose is that dam?—For the Craig Forth Mills.

Mr. *D. Stevenson.*
June 4, 1845.

1787. Can you state how high the tide rises on that dam, and how much higher it would flow if that dam was removed?—I think it rises about 4 feet there.

1788. Do you know how long Craig Forth Mills have been erected?—No, but they are very ancient.

1789. Did you examine so as to ascertain, if that was removed, what the effect on the tide would be?—No, not specially; but it would increase the influx of tide unquestionably.

1790. Do you contemplate any other improvement, except the removal of the fords, in the statement you have now given?—Nothing farther upon the estimate of 9404*l.*

1791. Are there any other projections or impediments to the flow of the water up to Stirling that could be removed with benefit to the navigation?—There may be some points where the river is probably too narrow, and some of those might be removed with advantage to the navigation.

1792. Looking at the course of the river from Stirling to Alloa, has not it been much narrowed by the general system of encroachment by banks throughout its whole length?—I should say that it has.

1793. Is it your opinion that the navigation up to Stirling has thereby been injured?—The tendency has been decidedly to injure it; but I do not know from my own knowledge that it ever was any better.

1794. (Mr. *Godson.*) How many miles by the river is it from Stirling to Alloa?—10½.

1795. How much by land?—7½ by the road.

1796. (Mr. *A. Chapman.*) Would it not be advisable to make a cut here and there?—You would lose a good deal of tide water if you cut off the different bends. The principal objection, however, is on the part of the landed proprietors, and the proprietors of the fisheries.

1797. (Mr. *Hume.*) Do you know when the lands you have mentioned were embanked?—No.

1798. (*Capt. Washington.*) Will you state the slope of the bed of the river between Stirling and Alloa?—11 feet 6 inches.

1799. What is the rise of the tide at Stirling, at Alloa, and at Leith?—Ordinary springs rise about 16½ feet at Leith, 19 feet at Alloa, and 8 feet at Stirling.

1800. (Mr. *Hume.*) Supposing these fords which are now detailed were removed, are you satisfied that the estimate you have now given would completely remove them?—Perfectly satisfied to the extent contemplated.

1801. Are you satisfied, after mature consideration, that the navigation to Stirling would thereby be increased three feet at least in depth?—Yes.

1802. Are there any other means by which the navigation could be further increased beyond the removal of the fords?—The fords could be further removed, and if the barrier at the Cruive were removed the tidal influence would be much increased.

1803. Did you observe the levels above the Cruive Ford, and how far, if it was removed, the tide might flow?—Not particularly, but I have no doubt it might be some miles.

1804. Have you surveyed the Forth from Alloa downwards?—I have seen it frequently, but have not surveyed it.

1804*a.* Have you visited or observed the encroachments made near Kincardine, on Lord Keith's property, whereon an embankment including many hundred acres has been finished, and another is now in progress?—I am quite aware there are such embankments; as to their extent I cannot speak.

1804*b.* Can you, from your knowledge, state what would be the effect if that encroachment which is now going on, on the tide flowing up or down the river, as to the formation of the banks opposite?—I should hardly like to give a decided answer without having visited the spot specially, and taken into consideration the configuration both of the Upper and the Lower parts of the river and Firth.

1804*c.* Then you are not able to say how far these encroachments will impede the flow of the tide upwards?—No.

[*The Witness withdrew.*]

Adjourned till One o'clock on Friday next.

Friday, 6th June, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir Gordon Bremer, K.C.B.	Captain Beaufort, R.N.
Mr. A. Chapman, M. P.	Mr. Godson, M.P.
Mr. Hume, M.P.	Captain Washington, R.N.

Mr. *Wm. Galbraith.*
June 6, 1845.

Mr. *William Galbraith,* sworn and examined.

1805. (*Chairman.*) You are the town clerk of Stirling?—I am.

1806. A memorial appears to have been presented by the Commissioners of Forth Navigation, stating that the navigation is greatly obstructed between Stirling and Alloa by several fords or shallows of the channel of the river; will you be so good as to explain the object of that memorial and the circumstances attending it, as far as they have come within your own knowledge?—I could not answer that question better than by referring to the Report of Mr. Stevenson, the engineer.

1807. (Mr. *Hume.*) What was the object of your application to the Treasury?—To see if the Treasury would advance money on the security of the rates.

1808. What Act of Parliament have you authorizing you to be conservators?—An Act of Parliament was passed in the year 1843.

1809. What was the purport of that Act?—Appointing as Commissioners the magistrates and town council of Stirling, with several gentlemen from each of the three adjoining counties, for removing the obstructions to the navigation of the river, and improving the harbour of Stirling.

1810. What authority does that Act give you as to raising money, and expending the money so raised in improvement?—It gives power to the Commissioners to employ engineers and others to dredge the river, to clear away those shallows and fords that are in it, and for that purpose to borrow money on the security of the rates.

1811. What was the amount in 1843 of your revenue?—The amount then and for a number of years prior to that, was 140*l.* a year.

1812. In what way was that money raised?—It was raised by dues levied at the harbour of Stirling on goods and on shipping.

1813. Has that increased?—It is now 350*l.* a year.

1814. What are the several dues you raised that money by?—Tonnage dues on vessels sailing on the river between Alloa and Stirling, and on their cargoes, and on passengers by steam-boats.

1815. What is the nature of the charge?—So much per ton on the vessels, and there is so much per ton on the cargo.

1816. Are the provost and senior magistrate for the time being, of the burgh, members of the Commission?—The whole members of the town council are members of the Commission.

1817. Can you state what was the extent of shipping when you got your Act?—There were twenty vessels belonging to Stirling, besides the half of two passenger steam-boats.

1818. You applied to the Government to obtain money from the Exchequer Bill Commissioners to carry out the repairs?—Yes.

1819. What amount have you applied for?—We have made no special application.

1820. Have you any estimate of what would be necessary to remove the fords which are complained of as an inconvenience to the navigation?—The estimate by our engineer is about 10,000*l.* for the fords, besides the sum necessary for the improvement of the harbour.

1821. Is it your intention to carry out the recommendation of your engineer if you had the means?—Decidedly.

1822. Cannot you borrow that money on the credit of the corporation?—We have not power by the Act to do so, and the corporation of course could not legally do it.

1823. Have you any power by that Act to borrow from other individuals?—Only upon the security of the rates.

1824. Is there any limitation to the amount that the Act authorizes you to borrow?—Yes; until we have expended 5000*l.* we cannot borrow any more than that sum.

1825. How much have you expended since the Act passed?—We have expended scarcely anything on the improvement, because the money we have got has been expended in obtaining the Act. We have made some small repairs of the harbour of Stirling, and improved some roads of access to the harbour.

1826. As the harbour is at the present moment, do you find the town inconvenienced by not admitting vessels to deep water?—Very much.

1827. Can you state what is the largest vessel that can reach the port?—Vessels, I believe, of 150 tons have been known to reach it, but when they do come there they are compelled to wait perhaps till the return of the next spring tide.

1828. What is the trade you expect to carry on if the harbour is deepened?—A great quantity of grain comes to Stirling; there are lime-stones to a very great extent; they are burnt at Stirlingshire and in the neighbourhood for the benefit of the farmers.

1829. To be used as manure for land?—Yes; and there is a great quantity of wool comes; but in many instances the vessels cannot come to the shore of Stirling, and the cargoes are therefore unshipped at Alloa and carted to Stirling.

1830. Have the Commission approved of that Report given in by Mr. Stevenson, the engineer?—The magistrates and town council proceeded upon this when they went to Parliament.

1831. Was that Report drawn up before the Act was obtained?—It was.

1832. Is the Report you have now laid on the table, the Report of the engineer proposing the alteration for which you went to Parliament to obtain power?—Yes.

1833. Since the Act passed, have you been able to carry out any part of that recommendation?—Scarcely any of it.

1834. What is the reason you have not proceeded?—Entirely from the want of funds. We have only succeeded in raising 1,600*l.*

1835. And now you apply to the Treasury for assistance from the Exchequer Bill Commissioners?—Yes.

1836. What security do you offer?—We have nothing but the rates to offer. (*See Appendix*, p. 163.)

1837. Would the town have any objection to become joined as a joint security?—I am afraid in present circumstances they would not agree to it. You observe this 140*l.* a-year went to the general revenue of the town; they abandoned that entirely.

1838. Have the corporation any debts at the present moment?—Yes.

1839. What extent?—About 10,000*l.*

1840. Might the income of the town enable them to pay that debt?—They have just now the customs leviable at the ports, about 1,600*l.* a-year.

1841. Would not the deepening of the harbour, as proposed by the engineer, tend very much to increase those customs and revenue?—I do not think that will increase the customs much; it would increase no doubt the revenue at the shore of Stirling, but I doubt whether it would increase our customs.

1842. Would not these revenues at the harbour benefit the town; and do you think that if

Mr. *Wm. Galbraith.*
June 6, 1845.

a public meeting was called the town would not authorize the corporation to become joint security for the money to be advanced by the Government?—I cannot say that they would; I am not prepared to answer that question.

1843. What are the conditions under which you can levy the dues on goods shipped and landed?—We can only levy one-third of the dues until we have expended 5,000*l.*; we can then borrow 4,000*l.* more, and we can only, till that is done, draw two-thirds of the dues.

1844. If 5,000*l.* was advanced towards the harbour, have you the means, from the dues now received, to pay the interest?—Undoubtedly.

1845. After 5,000*l.* expended, would the dues enable you, when increased, to pay interest on the 10,000*l.*, and also a sinking fund of 5 per cent.?—I have no doubt it would.

1846. Do you think there would be any objection to the Admiralty, or the Government, having the power to direct or superintend those improvements, if the money was advanced by them?—Unquestionably not; our object is merely the improvement of the river, and if the Admiralty took it into their own hands it would be satisfactory to us.

1847. Do you think the corporation, and all the present authorities under the Act, would concur willingly in receiving such suggestions, and acting under such orders, as the Admiralty, after due inquiry, might think best calculated to improve the navigation?—I have no hesitation in saying so.

1848. Could you lay before the Board a statement of what the shore dues and income of the Commissioners now is under the limited permission you have to raise; what would be the probable increase after an expenditure of 5,000*l.*, and increasing the dues; what the amount of shipping now is, and what your estimate now is of the increase, provided the navigation is improved by the depth of three feet, as Mr. Stevenson proposes?—Yes. (*See Appendix*, p. 163.)

1849. (Mr. *Chapman.*) Have you tried to obtain the money from any public body, or any Scotch bank?—Yes, we have applied to a number of banks; to the Bank of Scotland and the Royal Bank, among others, and they stated they were in the practice of doing these things, but now they have given it up entirely.

1850. (Mr. *Hume.*) Have you borrowed any money under the Act?—Yes.

1851. How have you expended it?—It has gone altogether in the expense of obtaining the Act of Parliament, including the report and survey of the engineer.

1852. (*Capt. Washington.*) Will you state the rise of tide at Alloa and Stirling?—At Alloa 19 feet, at Stirling 8 feet.

1853. Can you state what size ships come up to Alloa?—Ships of almost any burthen can come up to Alloa.

1854. (Mr. *Hume.*) Do you know under what authority Craig Forth Weir was made across the river?—It was under the authority granted by one of the kings of Scotland; he gave the right of salmon-fishing to the then Lord Elphinstone.

1855. Does that right of salmon-fishing authorize him to dam up the waters, so as to supply the mills with water?—I have never seen the grant, but I know it was so granted. The town of Stirling of the day objected to it, but the thing was overcome.

1856. Where is a copy of that grant to be got?—I have never seen the grant; Mr. Callender, of Craig Forth, is the proprietor.

1857. Is there a mill of any value there?—Yes; it has great power of water; but at certain times of the tide the back water prevents the mill going freely.

1858. Have you observed how high on the weir the tide-water rises?—No.

1859. Is there any document in the archives or records of the town of Stirling respecting the erection of that weir?—There is.

1860. Can you furnish a copy?—I can.

1861. To whom does the wharf belong where the steam-boats load?—The Commissioners.

1862. Have the Commissioners the possession of the harbour of Stirling?—They have; the town council gave it up to them.

1863. And they remain in possession of it for the public?—They do.

[*The Witness withdrew.*]

Mr. *J. M. Rendel.*

Mr. *James Meadows Rendel,* sworn and examined.

1864. (*Chairman.*) You are civil engineer?—I am.

1865. The questions laid on the table were put to you some time ago, I believe?—Yes.

1866. By whom?—Lord Stradbroke. (*See Appendix*, p. 175.)

1867. Were you asked to give an opinion upon this in a general point of view, or were you aware of the particular object in view when they were sent to you?—It occurred at a time when I had just been under a long examination with reference to some improvements contemplated on the Mersey at Liverpool; and the questions there raised were, how far it was beneficial or otherwise to a river like the Mersey to have any large irregularities on its shores, such, for instance, as side creeks embanked, and whether the water which filled those creeks would not, if the embankments were judiciously designed, pass into the higher parts of the estuary. I had prepared myself, by levels and general investigation of the Mersey, to show that the water did not rise to the height at the higher part of the estuary that it rises at Runcorn, and that it was principally owing to those inequalities or irregularities of the shore at the mouth of the estuary which prevented the quantity of water, escaping into those creeks, from passing up into the high part of the estuary, that, in fact, the momentum of the tidal stream was impaired at the mouth of the harbour by the inequalities in the sectional area of the channel arising from those creeks, and that any work which would have the effect of correcting that loss of momentum

of the water at the mouth of the estuary would have the effect of carrying a larger body of water into its upper portion. The evidence went to that; and the next morning I had from Lord Stradbroke these questions, to which I gave those general answers.

1868. Was the land adjoining the creeks to which you have referred covered at high water?—Yes, to different depths, varying with the tide. I should be very happy to explain to the Commissioners the principle upon which every answer was based.

1869. What tidal rivers and harbours have you examined and reported upon?—Very numerous. I believe there is hardly one in the kingdom of any importance I have not examined.

1870. Have you surveyed Southwold harbour?—I have not.

1871. Have you ever seen that?—I have never been there.

1872. (Mr. *Hume.*) Were those answers given in reference to Southwold harbour?—Certainly not; they were not given with reference to any particular harbour; and I informed Lord Stradbroke, when I put them into his hands, they could only be regarded as answers to abstract questions.

1873. Are you aware they have been considered as applicable to Southwold harbour?—I was not; because some time ago I had a letter from Lord Stradbroke, in which he asked if he might forward those answers of mine to the Treasury with reference to Southwold harbour, and my reply was that inasmuch as I did not know the harbour, and they were general questions, that it must be so stated if he forwarded them.

1874. You could not say whether they applied or not?—Yes; I gave Lord Stradbroke clearly to understand that they were to be regarded as general answers.

1875. In the course of your experience, have you been enabled to lay down any principle that would be generally applicable to the improvement of tidal harbours?—I have not; I find it necessary, in my experience, to treat every case according to its own peculiarities.

1876. Are the Commission to understand that the answers given to those general questions submitted to you by Lord Stradbroke could not be applicable to Southwold, or any other river, unless you had previously examined such river?—Clearly so. Indeed, I consider almost all those answers as emanating from the examinations which I had given a day or two before in the particular case that I have referred to. The great object of embanking a river should be to improve the course of its channel in such a manner that a smaller quantity of water should perform more useful effect than any larger quantity of water due to its natural shape could perform.

1877. Do you mean by narrowing and straightening the course?—Yes; and I will explain generally the view I have on a subject of this sort. If I could find two rivers precisely alike, I should then say that the improvement of those two rivers ought to be attempted precisely in the same way; but I have never yet found two rivers precisely alike. I will take this case of Southwold. Here I see there is a bar, and the whole coast encumbered with sands, and there are some antagonist principles at work. It is very clear that the consideration of an engineer would be first of all directed, if this harbour was to be improved, to what was best for the maintenance of an entrance. He would never think of looking at what was best for the navigation up the river until he had determined how far that plan, which he might otherwise propose for the improvement of the higher part of the river, agreed with what was necessary for the improvement of the entrance, because, supposing we could get 18 feet of water in the interior channels, if we did not at the same time maintain a good entrance, as far as the harbour was concerned the whole thing would become useless. I should say, in a case of this sort, the first thing to be considered would be how far any works which might diminish the area of the interior space would affect the maintenance of a given depth of water over the bar, because this is one of the cases which will always have a bar, and you cannot have it without a bar.

1878. You mean diminishing the flow?—Diminishing the quantity of water, because here unquestionably the good or bad state of the bar depends in great measure on the quantity of water passing to and from the estuary; therefore anything that diminishes the quantity of water (beyond that which is expedient to prevent a strength of current through the entrance inconvenient to navigation, which would be as bad for the harbour as a bar,) would unquestionably have a tendency to increase the bar, because it could only be kept in subjection by a considerable ebb current from the harbour. I should say that Southwold Harbour is one of the numerous class in this country that must be satisfied with having a good basin immediately within its piers, because I am quite satisfied, as a practical question, there is no hope of doing anything for the improvement of the upper navigable channels of such a harbour as this. There is not sufficient quantity of tidal or fresh water to enable you to effect it. This harbour or estuary must be looked at simply as a great reservoir, in which a quantity of water should be retained to keep in subjection the bar. If it were a matter of vital importance to the country that vessels of the class I was trying to accommodate within the harbour, should go a long way up into its interior, I should treat that harbour in a different manner. I should define one channel for the tide and fresh water stream, and contract it in such a manner that it should be able to maintain that particular channel to the required depth. Hence, then, I should be prepared to sacrifice some of the advantages which I was before anxious to obtain from a large body of water for securing the bar. The most perfect arrangement for a case of that sort that could be effected, if we had an unlimited amount of money, would be this,—to make a new straight and deep channel, which should contain the same quantity of water as this shallow and irregular harbour; but, commercially speaking, this is unattainable in all these little harbours. As I said before, there are many harbours where the stream is so great at the piers that it amounts really to a greater objection than the bar itself, and consequently there it is very desirable to lessen the stream.

1879. (*Capt. Beaufort.*) Will you mention one or two of those harbours?—The case that strikes me at the present moment most forcibly is Berwick. There the stream is frequently so

Mr. *J. M. Rendel.*
——
June 6, 1845.

great that it amounts to a greater danger than the bar; for if a vessel misses the pier heads the least in the world in beating in, and falls off, the stream carries her beyond the pier, she loses her way, and is drifted on a lee-shore, and consequently there the stream is the greatest impediment of the two.

1880. (Mr. *Hume.*) Then the bar is not in the way in that case?—The bar is a little further out, and there is a sand-bank, which amounts to a dangerous lee-shore between the bar and the pier.

1881. (*Chairman.*) What are the chief obstructions in the propagation of the tide that are usually found to exist?—The inequalities in the bed and shores of the river. I have always found in rivers of this sort that there is a great probability that the tide will be higher at the entrance than at the upper parts of the harbour. That arises frequently from two causes. We find it a practice with engineers, in order to have such a rapidity of current through the entrance piers as will drive away what is ordinarily called a bar, to contract the entrance so much that the tide has not time to fill the basin within. Now when that is the case it is manifestly an injurious contraction, because you are defeating the very end you have in view, viz., getting the largest quantity of water within the piers; and it is of great importance also that you should have as much water as possible in the higher parts of the harbour, because it will be very clear that the water which flows into this part is not only the last to ebb out, and, therefore, having the greater fall, produces a greater effect on the whole of the channel, but also performs its effect on the whole course of the channel; consequently it is very important to have the harbour in such a form that there shall be a higher tidal flow at the inner extremity than at the sea end. The Mersey is a case of this sort. The tide rises at Runcorn, which is about 20 miles from its mouth, from 18 to 20 inches higher than at Liverpool; but between Runcorn and the head of the estuary it falls, that is, there is a contraction at Runcorn which prevents the tidal wave from being propagated as fast above that narrow as below. It is very plain that anything that would take away that obstruction, anything that would enlarge that stricture in the river, and let the water up into the higher part of the estuary, would be a positive improvement. If in a river of this sort the entrance is so contracted that the water is throttled, it is manifest you are losing more than you are gaining by the increased stream. I should also say that I have, in all cases, a very great objection to a stronger stream than is absolutely necessary for the removal of the bar, for it creates that amount of disturbance which irritates the bed of the river unnecessarily, and is the cause of evils as great as the bar itself.

1882. Are you of opinion that depths in rivers and their powers of scouring are chiefly due to the volume of water brought down by freshes or tidal water?—That again does not admit of a general answer. In many rivers I believe the navigable channels owe principally their existence to the fresh water; in many others they do not. A case came the other day under my notice; that is, Belfast. I was of opinion that the slobs or mud banks on either side of the Lough of Belfast might be advantageously embanked, because I anticipated that the quantity of tidal water passing up beyond the proposed embankment, upon its return, aided by the river water, would maintain a channel, well defined by properly protected banks very much more efficiently than the channel could be maintained whilst unembanked. Now there is this very great advantage gained in a case of that sort. It is a fact well known to me, from my connexion with Lynn, that in the winter season, when one might expect from the quantity of sediment brought down by the Ouse the harbour would be in the worst state, it is always in the best state. This arises entirely from the harbour being more occupied by shipping in the winter than in the summer, when the extra scour produced by the partial obstruction of the shipping in the harbour tends to keep that harbour in good condition; and I have remarked it in many other cases. In navigable channels much frequented, particularly if by steamers, you get the channel into a better state than if it has no navigation. The conviction in my mind is, therefore, that in a case such as this of the Belfast Lough, where there are no injurious sand-banks at the entrance (for it is a long and deep funnel-mouthed bay, instead of an ordinary estuary), there would be no injury arising from the embankment of those slobs; but if one commits one's self to that as a principle, one would get into all sorts of difficulties.

1883. (Mr. *Hume.*) Might you not, as a general answer, say, that in all navigable rivers to enclose slobs or mud banks, so as to exclude the tidal wave would be injurious?—I should rather put it in this way, that in all estuaries encumbered at their entrances by sands, liable to great fluctuation from prevalence of winds, nothing that tended to lessen the quantity of water going into the harbour ought to be permitted; but if an embankment would have the effect of increasing the quantity of water going into the harbour, then, I say, it ought to be encouraged. It is a question of degree in all cases. It is too much now the practice to imagine that an embankment necessarily implies a diminished quantity of water in the harbour. It does no such thing.

1884. If you narrow the sides, and do not deepen the bottom, must you not lessen the volume to pass?—It by no means follows, as I know from experience, that cutting off a creek at the mouth of a harbour lessens the quantity of water flowing in.

1885. Are not the two creeks on each side, which you have cut off, filled with tide, and do they empty with the ebb; and, consequently, being shut out by these embankments, would not the outer scour be lessened?—No. Supposing it is found by levelling that a tide which rises at the entrance, say 20 feet, does not flow as high at this point as at that by two feet, which is frequently the case. We know perfectly well from our experiments upon a discharge of water through pipes that these two creeks act as bulbs, and distort the current flowing into the estuary in such a manner as to lessen its general momentum; hence it is, that if you cut off these creeks you do not lessen the quantity of water. The flow of tide at the mouth remains the same precisely, the basin is not full, and the water which filled these creeks will pass into the upper portion of the harbour.

1886. Are the Commission to understand that while you shut out a million gallons of water which filled these two creeks, the increase of the current will raise the level in the upper part, so as to admit more water than the million gallons which you have excluded?—I do not think it will admit more. If a harbour is not full, for instance, if the tide retreats from the entrance before the wave has been propagated to its full level at the extremity, it is manifest that the harbour is not full. If the harbour is not full, it is an evidence of one of two things, either that the entrance is not large enough for it, or that the current is so interfered with by sand-banks and irregularity of shores as to prevent the momentum of the wave accomplishing its full purpose.

1887. Are the Commission to understand that the existence of those two creeks act in a certain manner as if they were impediments to the general current?—I think they do; practically there is no such thing as an estuary of this form without banks and shoals. The banks and shoals are more or less occasioned by these creeks. I have hardly ever seen a deflection of current into these creeks that is not followed by a bank; and these creeks are the cause of many banks which reflect back the evil I have been referring to, that is really the case practically.

1888. Can you lay down any rule which would sanction the cutting off side outlets in estuaries or rivers, such as you point out?—No.

1889. Until you have examined the level of the water at any given point between which you wish to make the clearance, you cannot form an opinion what measures should be adopted?—You cannot.

1890. Are the Commission to understand you to give a decided opinion that before any creek, reserving tidal waters, should be shut up, you ought to ascertain the difference of level between the bar and the upper part of the harbour which you wish to fill?—The whole engineering condition of the harbour ought to be minutely investigated before any engineering works ought to be permitted.

1891. Having ascertained all the facts you have pointed out as necessary, is the object to be obtained; the admission of a greater volume of water into the harbour?—It is. In cases of this kind we are assuming that it is necessary to the condition of the harbour's mouth that the greatest possible volume of tidal water should pass in and out; we assume that as the state of the harbour which we are now going to speak of. Then, I say, the first business of the engineer would be to ascertain by levelling, and the fixture of proper tide guages at different parts of the harbour, the exact state of the tidal flow at springs and neaps, that is, to compare the flow of the tide at different parts of the harbour. If he finds that the higher part of the harbour is not filled to the same level as the lower part of the harbour, his business should be to design such works as would accelerate the tidal wave into the higher part of the harbour.

1892. If you were informed that in the River Tay by dredging, removing fords, and other obstacles, the tidal wave had been hastened in its approach to Perth by 50 minutes, would you from that conclude that the operation had been beneficially employed for navigation?—I should, but with this qualification, that it is perfectly practicable to accelerate the tidal wave, and yet to reduce the quantity of water in the harbour. I should say, that if the tide is accelerated in time and height, it is accelerated beneficially for the harbour, provided you have not reduced the quantity of water so as to affect injuriously the harbour's mouth.

1893. Does your answer imply that you narrowed and deepened, you did not diminish the volume?—Clearly.

1894. So as to maintain the same scour, but in a better direction?—Clearly; because in the one case it is benefiting the upper part of the harbour to the injury of the lower part, or the bar.

1895. Can you apply that generally to harbours, such as Southwold, where portions of the land on each side of the centre stream are covered with water?—I would apply it to all cases where harbours have at their entrances threatening sand-banks. These are subjects which involve so many considerations that I hope the Commission will not fancy I am fencing with any question; but it is really necessary to draw very minute distinctions; for instance, I will assume that one could afford to lose a certain portion of tidal water in Southwold harbour; I mean with reference to any damage that might arise from that loss at the bar. Then to benefit a town at the head of such an estuary, it would be justifiable in an engineer to accomplish the improvement of the higher part of the harbour, and to lose such a quantity of tidal water from the scour of the bar. It is a nice discrimination of all minute differences which constitutes the value of an opinion in cases of this kind.

1896. Then it appears from your opinion that the harbour may be injured by the mouth being too narrow, as well as by being too wide?—Frequently more.

1897. Is it a rule that the mouth should be of such width as to admit to the extremity of the harbour the tide, to the same level, by the time the tide turns at the mouth?—It is. If, however, I want to employ a very rapid current at the harbour's mouth, it may be justifiable to so contract it as to lose a portion of the water flowing into the upper part of the harbour; but that must depend entirely on the circumstances in which the engineer is placed, and the object which he has to attain. Hence it is one of those complex questions which can only be answered by reference to a particular case.

1898. Do not changes often take place in harbours where freshes and strong tides are admitted, so as to require constant watching and attendance on the part of some superintending engineer or surveyor?—Most decidedly.

1899. From your experience of harbours, are you able to state whether more of them have been injured by neglect than have been injured by injudicious application of improvements?—I believe many more have been injured by injudicious applications of what were considered improvements, than by natural decay.

Mr. *J. M. Rendel.*

June 6, 1845.

1900. Has your experience pointed out that local interests often interfere with the general interests of navigation?—Most destructively so.

1901. Is it then your opinion that every harbour should be placed under the superintendence of Government, unconnected with local interest, and directed solely to the general advantage of the nation, so that their improvements might be directed to general advantage, instead of local purposes?—If I thought that the Government could command properly qualified persons for the purpose of directing and controlling all these harbour improvements, I should say so; but unless men of competent ability and skill are called upon to control these works, I believe greater evil would arise from ignorance than from cupidity.

1902. The question is put to you under the belief that if the Government, the Admiralty, for example, had power deposited with them, and charge entrusted to them of all the estuaries and harbours of the country, that they would employ the most talented men the country could afford?—I have ever thought that the Admiralty is the proper Board to have the conservancy of the harbours of this kingdom; and although it throws upon the Admiralty a vast amount of additional labour, I am quite satisfied that any minor Board would want the influence which the Admiralty can exercise to overcome local influences, and that the present practice of referring particular cases, as they arise, to men of eminence, unconnected with the particular work, is the safest course the Government can adopt. In these days professional men who have acquired the eminence which could justify a public Board in deferring to their opinion, are so much employed, that the Government would not be able to monopolize their time. I cannot therefore but think, under all the circumstances, that the practice at present resorted to, of the Admiralty referring questions to five or six engineers, whom the country may consider as best qualified to give an opinion when called upon to do so, in any particular case, is the one after all that will give the greatest amount of satisfaction; and I think it is very manifest, from the way we see the Railway Department of the Board of Trade treated, that any minor Board would not be useful; in fact, the Admiralty would still be applied to, with, perhaps, the disadvantage of an opinion previously expressed by another Board.

1903. Your opinion is, that the influences likely to affect local improvements in the different harbours and ports of the country is so great that the Admiralty, being the most powerful, and entrusted with the most important interest, ought to be the party to have the check, and control, and direction?—That is my deliberate opinion.

1904. Have you considered in what way that check and control could be entrusted to that body, charged with other important business at the same time, and carried out?—The impression on my mind is, that it is necessary that a Board of this sort should have the full stamp of Government authority; and I doubt very much whether any Board in this country could have that strong impress, which is necessary for its usefulness, that had not all the disadvantages of a political Board.

1905. Are the Commission to understand that a supervising authority over ports and harbours of this country should vest in that body having the greatest political and official power in the administration?—I think so.

1906. With a view of having at all times information before the Admiralty, do you consider that that Board ought to have in their possession maps, surveys, and all the requisite information of every such port and creek in the country?—I think they ought; for I have found that the greatest inconvenience and difficulty, which engineers meet with in treating questions of this kind, is the absence of anything like a correct plan without putting the parties who call for his opinion to the enormous expense of these surveys. I think it is most material to the preservation of the public harbours of this nation that there should be at once made accurate plans, comprising the full extent to which the tide flows.

1907. (Capt. *Beaufort.*) Such as the Irish Ordnance Survey?—Yes; the most detailed surveys. It is only recently that the Admiralty Surveys have been worth anything, as far as harbours are concerned. It is only very lately that the Admiralty surveyors have given that minute attention to the peculiarities of an estuary which the engineer requires when he comes to consider its improvement.

1908. (Mr. *Hume.*) Have you considered whether, if an annual report of the changes, whether by improvements or by natural causes, that may have taken place in every harbour should be made to the Admiralty, that would be the means of preventing evil and promoting improvement?—I think in all cases where Acts of Parliament confer power of local conservancy upon corporations, that those corporations should be required, having been furnished with the first public plan of their harbour, to record upon it, from time to time, through the medium of the Admiralty, any changes that had taken place. There is nothing that would help the engineer so much as to know the history of the harbour that he is called upon to improve.

1909. Do you consider that it would be requisite to have an engineer officer appointed, whose duty should be to watch over and attend to the harbours in a given district of the coast, so that he would be prepared to report any change that was taking place?—I do not think it would be in the power of any individual to take such duties upon himself. I should prefer to have a Parliamentary compulsion upon parties to make these annual reports, than that there should be any officer appointed for that purpose. I do not think it would be in the power of any individual to record those changes which I am assuming ought to be recorded by the harbour-master, where there is one, or by the resident engineer, because it is a very difficult thing for a man who only makes occasional visits to a harbour to mark off those minute differences, material to the history of the harbour, which can only be correctly represented on the plan by repeating a part of the process of the original survey. In such surveys of harbours as I am now referring to, bench marks, permanently fixed along the shore, as a means of determining if any change has taken place in the level of its bed, are necessary. I doubt very much if this could be done by a *visiting* engineer.

1910. The question alluded to this, not that he should do it, but whether the officer having charge of all the harbours from the Thames mouth to the Frith of Forth could not visit places, examine the report made by the resident engineer, and so far be able, when called upon, to give information to the Admiralty on each of these points?—I think it would be ill attended to, and would prefer the reports of the local engineers than get them modified by the views and opinions of the superintending engineer.

1911. (Capt. *Beaufort.*) In that case would it not be necessary that that history of the port should, from time to time, be put in by a competent engineer?—If the harbour-master was a competent man, he would be sufficient.

1912. (Mr. *Hume.*) All your experience leads you to the opinion that the ultimate check and control over all works connected with harbours should rest with the Admiralty?—I think so; and I confess that, as far as I have seen, their decisions have been judicious, and there has been a proper amount of firmness in their maintenance.

1913. Are you aware that they seldom interfere, unless applied to?—I was not aware of that. If that is the case, I think it ought to be an indictable offence to interfere with any estuary without a previous communication with the Admiralty.

1914. Is it your opinion that every alteration in the tidal waters of this country, or navigable rivers, should be reported to and decided upon by the Admiralty, before it is undertaken and carried out?—I think it ought to be an indictable offence to interfere with the flow of the tide in the estuaries or harbours of this country, without a plan being previously submitted to the Admiralty and approved.

1915. Is it not equally necessary that all bridges crossing navigable channels, railroads, or other works interfering, should equally be reported, and under their direction?—Most unquestionably, all interference, whether from bridges across the stream, altering the stream, or any act involving a change should be submitted to the controlling Board, which should be the highest connected with the subject which the country affords, namely, the Admiralty.

1916. From your experience, can you state generally or point out any particular instance where alterations which have been made have injured harbours?—I know many cases where great injury has been inflicted upon harbours by works even authorized by Parliament.

1917. Under that impression, ought not every Act of Parliament interfering in any way, or giving power in any way to interfere, with the harbours of this country, to be passed under the direction and not without the sanction of the Admiralty?—Certainly; there ought to be no work permitted to be introduced to Parliament until it had gone through that ordeal with the Admiralty which it is obliged to go through with the Standing Order Committee.

1918. If your experience points out much injury to the harbours of this country from acts of commission, whether under Act of Parliament or otherwise, does your experience point out any instances where, through negligence or want of attention, harbours have been injured?—In many harbours that I have examined; and I have found acts of encroachment of a most dangerous kind from their being silently performed, and it is on that account specially that I should strongly urge the propriety of having harbours mapped out, and the limits of the tide laid down upon them. I know instances where landowners have, from a knowledge that they were doing wrong, made first of all a wicker embankment, then progressively a stone embankment, and ultimately shut out the tide altogether. In fact, that kind of insidious encroachment which escaped nine out of ten of ordinary observers is the kind of thing from which harbours in this country have suffered as much as anything, and I think more than from open acts.

1919. Those parties being generally the lords of the manor or parties interested in the adjoining land?—Clearly.

1920. If the conservancy under the Admiralty, to which allusion has been made, were properly constituted, and which you think ought to be constituted, such evils in future would be prevented?—They would; and I think it would not be amiss for the Admiralty, if a public Act was passed for the purpose, to have something like a veto in the appointment of the persons locally charged with the preservation of the harbour.

1921. With the view stated by you, in every commission appointed by Act of Parliament, or under any charter granted by the Crown, or under the power any corporation holds, should not the Admiralty have the power of naming a certain portion of the Board who are to have charge or carry out improvements or alterations in the river?—I have always thought so, and in several cases have reported to that effect. I think it would be a wholesome check to what goes wrong now in local management.

1922. Is the opinion you have now given of the injuries caused on the navigation of this country by lords of manors and proprietors of lands adjoining, who by their silent and gradual encroachments have done the injury, founded on your own actual experience as a surveyor?—They have come under my own particular observation.

1923. But which, from delicacy to the parties, you would rather not detail?—I conceive it would be inconsistent with my professional capacity to do so.

1924. But of the real injury done to the national harbours, and of the injury in progress, you are perfectly satisfied?—Perfectly.

1925. And the opinion as to the altered law and surveillance recommended is with the view of promoting the public good?—Entirely.

1926. (*Chairman.*) You were employed by the Admiralty to report on an embankment made by Sir James Carnegie in the harbour of Montrose?—I was.

1927. Did you make any report?—I did.

1928. Is the report laid on the table a copy of that which you sent to the Admiralty?—Yes.

1929. Will you state the substance of that report?—The substance of the report was this,

Mr. *J. M. Rendel.*

June 6, 1845.

that the encroachments had been made to an injurious extent; that as the encroachments had gone so far it would be better to compensate for them by improving the channel of the river that had been left than to remove the embankments and allow the tide to flow over the space as before, on this principle, that unquestionably the river, by running at the foot of high earthy cliffs, had encroached so much on the shore that unless an expensive embankment was made it would carry into the lower part of the harbour large quantities of soil as it fell from the cliffs; that if the embankment was removed, and things restored to their original position, then it would be desirable, as far as the harbour was concerned, to make a stone embankment along this shore, and that there were no parties prepared to do that. Then I thought it a judicious compromise, under all the circumstances, to let Sir James Carnegie have his encroachments, on condition that he would give us an excavation along the line of the new channel, and do certain other things which I recommended in my report.

1930. (Mr. *Hume.*) Your opinion given to the Admiralty was, that the encroachment was injurious, unless compensation were made by opening an equivalent channel?—Yes.

1931. If that was done, you consider that the enclosure might remain?—It might.

1932. But not otherwise?—Not otherwise; and he has resisted that.

1933. Did you go round the basin at Montrose, and observe whether any other encroachments had been made on any other part of the banks at other times?—I did. I observed that very considerable encroachments had been previously made, and that Sir James Carnegie was only following the bad example that was set him. Montrose is one of those cases which points out the absolute necessity, if you are going to preserve the harbours, that there should be a good engineering map made of them.

1934. Are the Commission to understand that that engineering map should be made under proper authority, and then lodged in the Central Office, under the Admiralty, in order that they may at any time detect any encroachment?—Decidedly so, as a public document for public reference.

1935. Does your report state the amount of gallons or cubical feet of water excluded by that enclosure?—Ten millions and a half of cubic feet at ordinary spring tide.

1936. Did you observe of what extent the other encroachments were?—They have been very extensive on that estuary. The whole of the upper part of the estuary has, more or less, been embanked.

1937. Although the harbour trustees of Montrose have, by Act of Parliament, the superintendence and power to regulate and manage the harbour and basin, is it your opinion that the Admiralty should have the charge over them in that harbour as well as in all others where the navigation is affected?—Certainly; I think it should be general; I think it should apply to all harbours.

[*The Witness withdrew.*]

Adjourned till Wednesday next, at 1 o'clock.

Wednesday, 11th June, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir GORDON BREMER, K.C.B.	M. A. CHAPMAN, M.P.
Mr. HUME, M.P.	Captain BEAUFORT, R.N.
Mr. RICE, M.P.	Captain WASHINGTON, R.N.

Mr. *H. C. Chapman.*

June 11, 1845.

Mr. *Henry Cleaver Chapman* sworn and examined.

1938. (*Chairman.*) What is your profession and place of residence?—I am a merchant and ship-owner at Liverpool.

1939. Have you been at sea and in the habit of trading to Liverpool?—Not to Liverpool, but to London formerly; but I have been resident at Liverpool for fifteen years as a ship-owner.

1940. How long have you been at sea?—I was at sea about twelve years.

1941. (Mr. *Hume.*) Are you now a member of the Dock Board at Liverpool?—No; I have been, but I resigned.

1942. How long were you a member of that Board?—Two years.

1943. Had you an opportunity of attending to the state of the navigation which is under the management of that Board?—Constantly; it came before the Board on every Board day.

1944. Were you at Liverpool when the discovery of the Victoria Channel by Captain Denham took place?—I was.

1945. What was then the state of the harbour before, and what has been the result of that discovery?—It is no new discovery; it has been there from time immemorial; it will be found in an old Admiralty Chart of Greenvile Collins, of 1688. It was published when William III. embarked at Hoylake, which is close to Liverpool. At that time the ships used to lie there and discharge their cargoes, and come up the inner channel when they had lightened; but he remarks upon that Chart, there is a channel called the Formby Channel, with three fathom water, but not being buoyed off is not known; and that remained down to the time Captain Denham came.

1946. Are the Commission to understand that until Captain Denham surveyed the whole estuary, that channel which was known a century ago, and recorded, as you state, on an old map had not been used by the trade of Liverpool?—Occasionally steam-boats and fishermen

who knew it well, would run across; but the pilots always set their faces against it, and would merely call it, by way of getting it into disrepute, the Swashway.

1947. How has it been buoyed?—After a great deal of importunity, the Dock Committee at last allowed Captain Denham to carry out his plans; but they thwarted him in almost every possible way, grumbling at the expense, and thinking it all useless; that the old channel had done very well before, and they could go on in the same way. At last he succeeded, and when they found the channel of such infinite service they were obliged, in deference to public opinion, to complete it with a lighthouse and light ships.

1948. Was Captain Denham employed to survey under the hydrographer?—Yes; previously to being engaged by the Dock Committee.

1949. And it was upon his suggestion and urgency that the Dock Committee allowed the buoys to be placed in that channel?—It was.

1950. What has been the effect on the navigation since that period as to the facility of entrance or exit?—It has, in point of fact, made Liverpool the port it is. We have a good passage in or out with the aid of steam, and nothing could be better.

1951. Can the harbour now be taken in the night, in consequence of the arrangements that have been made with ease, whereas formerly it could not?—Formerly it could not at all be taken by a sailing-vessel, but now with that new channel and a leading wind, I would as soon take a line-of-battle ship in there in the night as in the day.

1952. With perfect confidence?—Yes.

1953. Did Captain Denham make a proper survey of the estuary?—Yes.

1954. Was it in the course of that survey that he discovered this channel?—He discovered the utility that this channel could be made to the port.

1955. Are you aware whether any report had been made to the Admiralty by any preceding individual of the possibility of making that channel useful for navigation, as it has now been made?—I am not aware that any had gone up from Liverpool until Captain Denham made his report.

1956. If the Admiralty had ordered a survey, or had had a proper chart of the estuary of the Mersey years ago, do you consider that that passage would have remained in the state of neglect in which it has remained?—Certainly not.

1957. You stated your anxiety to see all the lighthouses of the country under the superintendence of some central board. Have you directed your attention to what would be the benefit to be derived if the harbours generally were so placed as that the Admiralty should have a knowledge of every harbour, creek, and estuary, by survey, so as to be aware of any change, either of improvement or from neglect that may take place?—The benefit would be almost incalculable, because you cannot expect to find in small outports scientific knowledge, or that with knowledge, you can get men, if it affects their private interests, to take a national view of the question. I assert that although a few individuals may be benefited very often, yet grea national injustice and injury is done.

1958. Are the Commission to understand you to state that the estuary of the Mersey should be considered as a national harbour, and consequently that, although local Commissioners might conduct the business of the harbours, yet that there ought to be a superintending care to protect the harbour for the nation?—Yes; Government taking advantage of the Liverpool Dock Trustees, when they went to Parliament, and were squabbling amongst themselves, did appoint a conservator for the river Mersey, but they omitted to give him jurisdiction over the river Dee also. The works of the docks in Liverpool have completely silted up the Rock Channel; and in consequence of encroachments I have always understood that the river Dee, up to Chester, is not navigable for vessels of any size.

1959. When was the conservator appointed in Liverpool?—Three years ago.

1960. Who is the officer?—Captain Evans, of the Royal Navy.

1961. Has that appointment given satisfaction to the commercial interests at Liverpool?—Very much so.

1962. Are the Commission to understand that the tidal water from the Mersey has in some degree interfered with the navigation of the Dee, and that you think there ought to be a superintendence, not only over one, but over both?—Over both. I think the one who has superintendence at Liverpool ought to have jurisdiction over the Dee also.

1963. Are the Commission to understand that you mean there ought to be a general superintendence over harbours along the coast, of some authority, in order while you are improving one part to prevent injury to another?—I think they ought generally to be appointed, and I more particularly mention Liverpool and the Dee, being able to speak of the local advantages which would occur there. The inference is, that that would take place throughout the country.

1964. Do you think the same surveillance or superintending power which you consider would do good to the Dee and the Mersey, would equally apply to every other part of the country?—Yes.

1965. Has that been a question of conversation with the ship owners and mercantile men of your acquaintance?—Not so much so in Liverpool, because, as far as the lighting and buoyage goes, it is very complete under Lieutenant Lord, R.N., and Mr. Jones, R.N., his assistant.

1966. It being now complete, does not alter your opinion of the necessity of a general superintending power, to take care that no mischief in future arises?—No.

1967. Were you at Liverpool before 1839?—Yes; I went to Liverpool in 1830.

1968. Between 1830 and 1839, what was the state of the navigation there regarding lights and management?—It was very bad indeed, and constant losses were taking place. Even a buoy was grudged if it was wanted to be put down to make the thing perfect.

Mr. *H. C. Chapman.*

June 11, 1845.

1969. From what period did the improvement take place?—From the time Captain Denham was appointed.

1970. Then you consider Captain Denham's recommendations and assistance there to have been highly useful to change a bad into a good system?—Undoubtedly.

1971. In speaking of the superintendence, do you consider that it would tend to the general improvement of the harbours in this country if the Government were possessed of an accurate survey of every creek, port, and harbour navigable, to which reference might be had as to the present state, and consequently for reference in case of any future alteration?—The greatest possible advantage to the country; and the great wonder is, that it has not been looked into before.

1972. You think that it would meet the approbation of the merchants and ship-owners generally?—I am quite satisfied about it; and if there was any difficulty about the expense, we should be happy to pay a tonnage duty.

1973. You consider the preservation of the harbour, from negligent management, of so much importance, that even if expense was an objection, you would not object to a moderate charge for that purpose?—Not at all.

1974. (Mr. *Rice.*) Are you of opinion that the navigation of the Mersey and the security of it was very much benefited by that Conservancy Bill?—I think so.

1975. From your experience during your residence at Liverpool, is it your opinion that local management often has interfered with what ought to be national objects?—Undoubtedly; I do not think any person in Liverpool will attempt to say to the contrary.

1976. Is it your opinion that that sentiment is generally entertained by the ship-owners and merchants?—It is; and I am now deputed by the ship-owners to appear for them. I can speak their sentiments. We were just on the point of memorializing Government to put the Liverpool Docks under a Government commission, so badly do we conceive the thing has been managed, they are in reality national harbours under local trustees.

1977. Was that conversation to which you allude at the Committee of a Ship-owners' Society?—It was.

1978. And you have been deputed by that society to come to London to represent the state of the lighthouses and the navigation there?—Yes.

1979. Do you think that any Board should have the power of interfering with the navigation of this country, without the previous sanction and authority of a central Board, such as the Admiralty?—No, I think the central Board would then be held responsible; there would not be local interests to bias them in any way, their object would be the national good.

1980. You are convinced that great benefit has arisen from the appointment of a conservancy of the River Mersey?—Yes, we have now some security.

1981. Do you from that benefit consider that the same good would result if that was carried through every port and creek in the country?—Decidedly.

1982. (*Capt. Beaufort.*) Under whose care are all the lights and buoys, and ships, and everything connected with Liverpool?—The Dock Committee.

1983. How are the Dock Committee elected?—Thirteen of them are sent from the Common Council, and eight elected by the Dock rate-payers.

1984. Have commercial or maritime interest any voice in electing those?—Out of the 21 members, 13 are sent by the Common Council and eight are elected by the Dock rate-payers.

1985. Was it usual to have any seamen among those trustees?—They have had some.

1986. Was it of necessity to have a certain number of maritime people among the Dock Trustees?—Not at all.

1987. (Mr. *Hume.*) There being a sailor or not appointed to that Commission depended on their being members of the Town Council?—Yes, formerly.

1988. Do not the 13 deputed depend on the political opinions of the majority of that Council?—Entirely.

1989. Consequently the real interests of the harbour in selecting the best qualified sailors and the most scientific men formed no part of the ground of selection?—Not at all.

1990. Does the same political bias actuate or aid in the appointment of the eight Dock rate-payers?—Always, political management has been the curse of the Dock estate.

1991. In the evidence you have given, are the Commission to understand that you would wish to see the navigation of the Mersey conducted by persons selected according to their ability, and not by political party?—Entirely so, but this can only be done by altering the constitution of the trust.

1992. (*Capt. Washington.*) Have you ever sailed a ship through the Victoria Channel?—I have been with steam-boats and yachts in and out frequently.

1993. (Mr. *Hume.*) Have you any suggestions to offer with respect to the improvement of the navigation of the Mersey, or any other harbour?—Nothing, except having a superintendence over the harbour. The Mersey being a very rapid and deep river, must, more or less, affect all the tidal places adjacent. Also, if I may express my opinion, I think that Government should embrace the opportunity of altering the constitution of the Liverpool Dock Trust when the Trustees again apply to Parliament for a new Act. The rate-payers should be convened annually, and the trustees compelled to render an account of their stewardship, and the ship-owners and merchants allowed an opportunity of stating their complaints.

[*The Witness withdrew.*]

Mr. *Charles Hicks*,
Mr. *David Manser*, Clerk to the Rye Harbour Trust, and
Mr. *Henry Stocks*, Rye Harbour-master,
} Sworn and examined.

[*Mr. W. Cubitt's large plan of Rye, on the scale of* 61 *inches to a nautic mile, made by Messrs. Sherrard and Hall, engineering surveyors, in October,* 1839, *with numerous sections, was exhibited.*]

1994. *Chairman.* (To Mr. *Hicks.*) Are you the chairman of the Rye Harbour Trust, and reside at Rye?—Yes.

1995. How long have you been acquainted with the harbour?—30 years.

1996. Did you sign the memorials of the 22nd of May to the Admiralty?—I did.

1997. What is the present state of the harbour with respect to navigation?—Very bad; it has been better probably than it is now.

1998. Will you state briefly the former state of the harbour?—In the year 1813 or 1814 it was very much worse than it is now, and there was a good deal done to it then by erecting jetties on the westward. There are opinions as to the advantage of either western or eastern groins. Our harbour cannot be kept open without groins from one side or the other; and I hold in my hand two reports by Mr. Cubitt, one dated the 29th of July, and the other dated 17th of April, 1839. In his first report he speaks of the jetty which then stood at the western entrance, and states that the last length of the western groin he desired to be completed, and that the deepening of the channel appears to have been judiciously begun. That report was laid before the Commissioners of Rye Harbour, but they did not concur in it. He came down again in 1839. During this time the majority was against the views he had taken, and they built the eastern groin which is now standing.

1999. (*Capt. Washington.*) The Commission would not receive the report, because they did not approve of it?—They would not.

2000. (Mr. *Hume.*) Did the Commission take any other advice?—No.

2001. They acted on their own judgment?—Yes; he was sent for again in 1839, and he made another report, and he recommended the eastern groin to be also continued, because they had been at so great an expense.

2002. Between the report of 1833 and 1839, had the Commissioners erected the eastern groin which he now recommends to be extended?—Yes.

2003. (*Chairman.*) Under whose direction was the eastern groin erected?—The Commissioners of Rye Harbour.

2004. Against your opinion?—Yes.

2005. (Mr. *Rice.*) Not subject to the report of an engineer?—No.

2006. Was it subject to the opinion of the harbour-master?—No, I think not; it was voted at the Board on the view of a certain number of Commissioners. There has been a western groin and an eastern groin, and then there was an eastern groin, and then a western groin, according to the majority of people sitting as Commissioners.

2007. (Mr. *Hume*). If there had been a power in the Admiralty, or any superintending power to have decided, it would have prevented that from taking place?—Yes.

2008. Would that have been consistent with your wish and the opinion of the Commission generally?—I stated at the Commission that I should cease to take an active part till there was some authority to go by, and that I wished the Government would direct what was to be done, because I have seen the effects of it on the harbour of Newhaven, where they act under a consulting engineer every six months; and that harbour within my time has been very much improved; but where it is subject to the vote of a variety of Commissioners, one party often counteracts that which the other has done.

2009. Then, your opinion is that the harbour would have been better if there had been one system adopted and judiciously carried on under a superintending power to check these changes?—Yes.

2010. (*Mr. Rice.*) What is the number of Commissioners altogether?—Forty-eight.

2011. What is the amount of the usual attendance?—They pretty tolerably attend when anything particular is going on.

2012. (Mr. *Hume.*) What class of people are they?—There are 12 Commissioners from the landed interest; 12 Commissioners from the corporation; 12 Commissioners holding certain quantities of shipping; and 12 Commissioners from the householders.

2013. Has the navigation been improved since 1839, when that groin was established.—Decidedly not.

2014. What is the depth of water now up to Rye?—We have got up to the town about 10 feet water at high-water spring-tide.

2015. How high does the tide rise?—About 22 feet in the Rye Bay.

2016. Have you in your possession any old map of what the harbour of Rye some centuries ago was?—I think the earliest is Smeaton's.

2017. What year was that?—1750, or thereabouts.

2018. What was the state of the harbour at that time?—There was then the new harbour, but they have resorted back to the old one now.

2019. Where was the new harbour there?—To the westward, close under Cliff End.

2020. (*Capt. Washington*). Why was the old harbour shut up?—In consequence of the beach, which is always shifting from the west to the east. When I say it is always shifting, I conclude that three-fourths of the time we have winds from westward, compared with what we have from the east, because if you have a long range of easterly wind, the beach then shifts to the westward; but the prevailing wind is the south-west, consequently it brings the beach

Mr. *Charles Hicks* and Others.

June 11, 1845.

along the shore in greater force than it is carried back again. But the great thing we have also to contend with in Rye Harbour, is Fairlight Cliff, which is constantly falling down; that is composed of clay, and it lies about in the bay, and in gales of wind from the south-west, it is washed to pieces, and forms an alluvial deposit, and which it has done from time immemorial; a great part of Romney Marsh is composed of it. After a gale of wind, you may see large lumps of clay rolling about the mouth of the harbour.

2021. (Mr. *Hume.*) Whereabouts is Fairlight Cliff, as connected with the town?—About six miles to the westward.

2022. How far does the tide flow up the river Rother, beyond the town of Rye?—There are three rivers—one called the Brede, the Tillingham, and Rother.

2023. They have all sluices, and where?—All within a mile of the town.

2024. Do these sluices stop the flow of the tide?—Decidedly.

2025. How high above those sluices would the tide flow, if there were none?—I should say the water would not flow more than five miles up the Tillingham. Up the Rother it would flow ten perhaps, and the Brede about seven.

2026. At what times where those sluices erected?—Three of them were erected 50 years ago; they are now destroyed, and they were renewed about 10 years ago.

2027. Were they erected by Act of Parliament?—Yes.

2028. Is there any record to show what quantity of water was prevented flowing up by the erection of these sluices?—I cannot speak to that, because it is so long ago.

2029. Have you any means to show how much land was covered by the tidal water before those sluices were erected?—No.

2030. What is the greatest depth of water that has existed up to the town of Rye for ships within the memory of man?—I do not think it is much narrower than it used to be, or else the depth is not much different.

2031. (*Capt. Washington.*) Do not you recollect Scot's Float Sluice being broken down?—Yes.

2032. (Mr. *Hume.*) In what year was that?—In 1813.

2033. By whom was it broken down?—By the tide.

2034. What was the effect upon the tide after it was broken down?—It went up the River Rother.

2035. How long was that sluice down?—About two years.

2036. What was the effect upon the harbour of the tide flowing up during that time?—It deepened it to a certain extent, but I do not know that there was a great deal of difference.

2037. Was there any engineer employed at that time, or have you any report of what the effect on the depth of water in the harbour was at that period?—Mr. Rennie's must be the nearest to it, but what that contains I cannot recollect.

2038. By what authority was that sluice shut up again?—By Act of Parliament.

2039. (Mr. *Rice.*) By what means was it paid by the Act?—By a scot on the land all above the sluice.

2040. (*Capt. Beaufort.*) (To Mr. *Manser.*) Was there much land inundated and damaged by the sluice being broken down?—I believe there was.

2041. How much?—I cannot say.

2042. Could that land be preserved by parallel embankments instead of being shut off by a sluice?—I think it could, at a very great expense.

2043. (*Capt. Washington.*) (To Mr. *Stocks.*) Do you remember when Scot's Float Sluice was down two years, what was the effect on the harbour?—The flux and reflux was a great deal better, by which the harbour was kept clear.

2044. Could not boats at low-water spring pull up to the town?—Yes, at low-water spring.

2045. (Mr. *Hume.*) Had that increased tide come on after the sluice was broken down?—Very shortly afterwards; as soon as the water got its run up into the country.

2046. What was the effect on the bar?—The bar is subject to vary and shift.

2047. Was the bar or entrance at the mouth deeper during the two years the sluice was open?—Yes.

2048. What was the effect after shutting up the sluice?—The west bar projected across the entrance, and turned the water down to the eastward, and made the channel crooked, and the sand accumulated outside.

2049. What was the difference of the flow of the tide in spring tide when the sluice was down?—The in-drift was so great that there would be 2 feet fall at the pier head while the water was still running in at spring tides.

2050. Do you mean the ground to be filled was so extensive after the sluice was opened that that was the difference of height at the bar and at the quay?—The water before it gets its level up the country would fall 2 feet at the pier-head.

2051. What is the largest vessel you have known during that period come up to Rye?—We have vessels now that come up at moderate spring tide of 11 feet draught of water.

2052. When the sluice was broken down, how many feet water was there?—Nearly the same.

2053. But the current more rapid?—Yes.

2054. Have you not stated that the current was stronger, and that the bank at the bar was also removed?—The out bar was partly removed.

2055. And that on shutting up the sluice one of the banks at the bar shot across and impeded the harbour?—It shifted down towards the eastward.

2056. (Mr. *Rice.*) Had you a better harbour when that sluice was down than you have had since?—Yes.

2057. (*Chairman.*) Is it your opinion that the shutting up that sluice tended to injure the

harbour of Rye considerably?—I contend that where there is a flux and reflux tide, and the tide has to make a run, the harbour will be the gainer by it.

2058. If you had the full run of the tide 15 or 16 miles up, from your experience, what would be the state of the bar, allowing for the drift of the shingle from the east or west winds, as they may prevail?—The bar is liable to shift according to the summer or winter freshes, or prevailing winds. There is generally a shifting of the bar twice a year. In the winter freshes, when the tide runs strong, sometimes they carry a straighter passage out.

2059. If the sluice had not been erected, and the tide had full flow 10 or 12 miles upwards, would not that current have tended to keep the harbour still clear?—With proper works to be erected; but when a tide comes below the two extreme points and expands, different channels will be formed; and where ever it expands outside the works that are carried on the expansion of the water lessens the force of the current.

2060. If the volume of water was increased, and the current also increases, the entrance would be improved?—Yes, by the works now carrying on to the eastward.

2061. (*Capt. Beaufort.*) Have you ever dredged the channel at all?—We have no opportunity: our funds are so limited, that we have no property to do it.

2062. Would dredging be a great advantage to you in clearing the channel?—I think it would.

2063. (Mr. *Hume.*) (To Mr. *Hicks.*) What is the revenue arising at the harbour?—The average of late years has been 1300*l.*, but since the South Eastern Railway has taken off a great deal of the trade, only about 1000*l.*

2064. How is that raised?—A shilling a ton on the registered tonnage on all loaded ships coming into the harbour.

2065. How is that expended?—On the harbour in various ways.

2066. On works?—Yes, for instance, erecting that eastern jetty has cost a great deal of money.

2067. On the average of the last 10 years, can you state precisely the revenue from the harbour?—About 1300*l.*

2068. (Mr. *Rice.*) And that has now diminished?—That has diminished to 1050*l.*

2069. (Mr. *Hume.*) How has that been expended?—For the purpose of paying interest of money in some instances, and otherwise towards erecting this central pier, and a variety of other works.

2070. Is there any debt at present on the harbour?—Yes.

2071. To what amount?—1500*l.*

2072. (Mr. *Rice.*) (To Mr. *Manser.*) Was that Act of Parliament for making that sluice obtained by a resolution of the Harbour Commissioners, or was it obtained by the land-owners themselves?—By the Commissioners of sewers.

2073. (*Capt. Washington.*) Whose money paid for the erection of it?—The land-owners.

2074. (Mr. *Rice.*) There was considerable opposition to it?—Yes.

2075. (*Capt. Beaufort.*) (To Mr. *Hicks.*) And of that 1300*l.*, what are the usual expenses of harbour master, boat, and messenger?—I suppose the standing charges are from 300*l.* to 400*l.* a year.

2076. So that you have about 800*l.* or 900*l.* a year for the improvement of the harbour?—Not more than 600*l.* now.

2077. (Mr. *Hume.*) It appears from your evidence that a considerable amount of money has been laid out, first on one side and then on the other, and that no determinate plan has been acted upon?—Decidedly.

2078. And it is your opinion that if there had been some superintending authority, to whom reference could be made by the local Commissioners, that that would have been in some degree saved?—I am sure of it.

2079. (Mr. *Rice.*) Do you think, if it had been under the superintendence of the Admiralty at the time that the sluice was made, that Act of Parliament would ever have been passed?—I do not know what to say about that; I have my own opinion: I have heard so many opinions; the first great engineers have been down there, and say you ought to have a sluice here, when the general opinion has been against a sluice altogether.

2080. (Mr. *Hume.*) Some of those engineers were employed by the Commissioners of Sewers, were they not?—Yes, and some by the Admiralty.

2081. Who do you mean by the Commissioners of Sewers?—Those who owned land of 200*l.* a-year.

2082. In what position?—On the banks of the River Rother.

2083. (To Mr. *Manser.*) Under what authority were they constituted?—In 1830, I think, the Act was obtained, under which the Commissioners were appointed and are now acting.

2084. Do you know whether any portion of the harbour dues has ever been applied by the Commissioners of Sewers to embank the lands which they had?—Not above the sluice.

2085. Below the sluice have you known it?—No.

2086. Do you consider those embankments and improvements below the sluice have improved the harbour?—No, I do not think they have improved or injured the harbour.

2087. Have they shut out a large portion of tidal water?—The water has flowed over 734 acres where it does not flow now.

2088. (To Mr. *Stocks.*) What has been the state of the bar since these 734 acres were inclosed?—There has been very little difference in the state of the depth of the water, but the channel from the harbour has narrowed considerably for want of that quantity of water that used to flow over; the harbour has narrowed considerably since the embankment has been down. The depth of water in the guzzle or channel is nearly the same. For want of flow these artificial scours have not force enough to carry away the silt that settles at a high tide, but only keep the bottom clear.

Mr. *Charles Hicks* and Others.

June 11, 1845.

2089. The width of the channel has been considerably decreased?—It has.

2090. The flow of water has not been sufficient to carry out the silt beyond the mouth?—No.

2091. Do sailing vessels go up to Scot's Float Sluice?—They are all sailing vessels.

2092. (*Capt. Beaufort.*) What height are their masts?—70 feet is the highest.

2093. Are they made with falling masts?—No.

2094. (Mr. *Hume.*) Would the erection of those bridges stop the navigation up to that sluice which you have now stated?—Entirely.

2095. If the sluice was removed entirely, how much higher could these vessels go?—The bridge would only allow them to go three miles.

2096. Do they narrow the channel much?—A little.

2097. Do any barges or boats go to the westward?—Continually.

2098. Carrying stores or goods?—Coals, chalk, and merchandize up and down.

2099. How high up the stream does any boat go with coal or other articles?—To Bodiham Castle.

2100. How far is that?—About 15 miles.

2101. Then the navigation interrupted by that sluice for large vessels is continued to boats for 15 miles beyond it?—It is.

2102. During the time that the sluice was down, are you able to state what sized vessels could have gone up to that castle?—None; the sluice being down, would not have permitted the vessels to go further than the bridge.

2103. Supposing the bridges across the river were removed, and the sluices removed, and the flow of the tide permitted, to what extent do you consider the navigation of vessels above 60 or 70 tons could be carried above Scot's Float?—It is a delicate question to be answered, it having been so long shut up. There is no telling what effect the run of tide might have upon it.

2104. Do you know what depth of water there is now with all the bridges across, and what boats go up to that castle?—No; at spring tide I suppose vessels of ten feet water may go as far as Newenden.

2105. Judging from the effect by the scour of the tide when the sluice was down, do you expect that the channel throughout would be deepened if the tide was allowed to flow up?—It would be a natural consequence.

2106. Have you ever any great floods down the Rother and the other three rivers flowing into it?—The floods are so great at times in the Rother with very heavy freshes, that barges can scarcely get under the bridges.

2107. Would not these freshes, if there was no interruption to the navigation, tend gradually to deepen above, and also to improve the bar below?—The sluice-keeper is as glad to get rid of the freshes as he can possibly be, and he opens the gates and every thing when there is a fresh that the land may not be flooded. There would not be more down-set than there is now.

2108. (Mr. *Rice.*) I suppose they would run the sluice at low water?—Yes.

2109. (Mr. *Hume.*) You would have the benefit of the flood tide?—Yes; in keeping it moving, both ebb and flood.

2110. (Mr. *Rice* to Mr. *Manser.*) Does the plan annexed to the Act of 1833 represent what the harbour was before the passing of that Act?—Yes.

2111. At that time was there a large creek in the harbour which is now inclosed by the embankment?—Yes.

2112. (To Mr. *Stocks.*) Do you know at all what was the depth of water in that creek?—Dry at low water.

2113. (Mr. *Hume.*) What was it at high water formerly?—Ten or eleven feet.

2114. (Mr. *Rice.*) Was that made any use of for boats, or any purpose at that time?—None; there was a dam thrown across 57 years ago to stop that channel, but at the place where they had put the wall across at the lower end, it was not stopped. The upper part was stopped, and that turns all the water into this north channel.

2115. That creek is now banked off and is dry land?—Yes; there was a number of creeks up and down on both sides, which is now all silted up.

2116. (Mr. *Hume.*) Do you consider that those creeks and the marshes that are now shut out, being full of water, had any effect on the bar in clearing the harbour low down?—The effect of the channel of the harbour by the late embankment has been to narrow the sides of it and confine the water to a narrow compass below, so that a barge can scarcely lie alongside a vessel in the channel.

2117. Are the Commission to understand that from want of current to sweep out the silt, it has increased on both sides until a vessel and barge can scarcely lie abreast of each other?—They cannot.

2118. (*Chairman.*) (To Mr. *Manser.*) Whereabouts do the South Eastern Railway Company propose to cross the harbour channel?—On the eastern side of the Fish Market.

2119. (Mr. *Rice.*) How much is that below Scot's Float Sluice?—A mile.

2120. (Mr. *Hume.*) What is the distance from the town up to Scot's Float Sluice?—About a mile and a quarter.

2121. Is it navigable all the way up?—Yes.

2122. For what size vessel up to the sluice?—Vessels of 80 tons go up.

2123. Is there any jetty or harbour for landing at the sluice?—Yes.

2124. What goods are landed and shipped there?—They consist principally of chalk, coal, and also a quantity of agricultural produce is exported.

2125. (To Mr. *Stocks.*) Have you any return of the amount annually landed and shipped?—I have.

[*The Witness delivered in the following Document*]:—

STATEMENT of the Number of Vessels which pass up the River leading from Rye Harbour to Scot's Float Sluice, above where the projected Railways are proposed to cross the River in each Year, on an average of Five Years:—

Coal-laden vessels, averaging from 70 to 100 tons	12
Chalk vessels to Mr. Smith's kilns	32
Vessels with rags or shoddy, and small vessels to Pollard's Wharf .	10
Vessels that lay out chalk below Pollard's Wharf, about . . .	60

Independent of which there have been about 20 vessels with stone and cement within the last three years.

2126. What is the width of the river at the spot where they propose to pass?—102 feet at low water.

2127. At high water, at a common spring tide, what is the width?—About 250 feet.

2128. Do the banks overflow so far as 70 feet on each side?—From low water mark.

2129. (Mr. *Rice.*) Is there an embankment of the land there?—There is an embankment on both sides.

2130. What is the distance between the land embankments?—About 250 feet.

2131. At high water spring tide, how near to the top of the banks does the water flow there?—From 18 inches to 2 feet.

2132. (Mr. *Hume.*) What is the height of the embankment above the level of the land?—In some places 4 feet, and in others 5 feet.

2133. If there was no embankment there, the whole of that land would be covered 3 or 4 feet deep with water during high water spring tides?—Yes.

2134. (To Mr. *Hicks.*) Can you state from an examination of the plans what would be the height of the bridge above the embankment to which you have now stated the water comes sometimes within 18 inches?—The Brighton Railway Company and the South Eastern Railway Company propose to cross within 36 feet of each other. The level of the Brighton is 1 foot under the top of the banks under the flow of high water, and the other is about 6 feet above.

2135. (To Mr. *Manser.*) Have you seen a section, and can you give a correct opinion at what height it is intend to cross the stream?—In the Brighton line the section shows a distance of only 4 feet 6 inches from the bottom of the intended bridge to the surface of the water at high spring tide. The South-Eastern shows a distance of 12 feet 6 inches between the bottom of their intended bridge and the surface of the water at high water.

2136. What span do they intend to cross it with, one arch?—I have not seen any drawing or specification of the intended bridge.

2137. You do not know whether any pier is to be placed in the middle, or whether it is to be a swing or a single arch?—I do not.

2138. (*Chairman.*) What effect will either of these bridges have on the navigation?—In whatever way the bridge is built it will be most injurious to the navigation. If it be what is termed an open bridge, on piles, it will stop the passage of all rigged vessels up to Scot's Float Sluice. If it be a swing bridge (owing to the nature of the channel, for I believe there are nearly 30 feet of silt above the bed of the present channel) the works to support it must be of that massive character, and the greater part of them in the middle of the channel, and must of necessity obstruct the flow of water.

2139. (Mr. *Rice.*) Looking to the importance of the flow of water and rigged vessels going to the sluice, which do you think would be the greatest detriment to the harbour, making a swing bridge with piers in the centre, and a much narrower channel, or an open bridge, which would not so much obstruct the navigation?—I am decidedly of opinion, the swing bridge would be the greatest injury.

2140. (*Capt. Washington.*) Can you point out where the railroad might cross without damage to the navigation?—On the north-eastern side of Scot's Float Sluice, without any injury.

2141. (Mr. *Hume.*) Supposing that sluice to remain?—Yes; I believe they might even cross Scot's Float Sluice itself, with a very trifling alteration.

2142. Are there any quarries in any part of the country on the banks of the Rother, to the westward of where the sluice is now?—I do not know.

2143. What probable chance is there of any great intercourse taking place up that river, if the navigation was improved?—I do not know of any increase.

2144. If the navigation was improved up to the 10 miles, would it afford any great facility to the agricultural produce?—No; I think it would not, because they have at present as much channel, and as much water, as they want for getting up barges of the description that usually navigate that channel.

2145. Are these barges loaded and unloaded from vessels below the sluice?—Yes; with reference to a swing bridge at the point they propose to cross the channel, (and I am borne out in my statement, by the opinion of the pilots, and nautical men in the habit of navigating that channel,) it would be almost impossible to get the vessels through. It would be difficult to direct the course of the vessel, in consequence of a very extraordinary set of tide, at a place called Fish Market, which is only a few yards to the westward, where they propose to cross the channel. The set of tide is so strong now, that vessels are driven from their moorings, and are carried down below the point where they propose to erect the bridge.

2146. What is the rapidity of the current?—From four to five miles an hour at the first flow and when they have got ten feet water in the channel it increases to six or seven.

2147. If a bridge is thrown across at all, not to interfere with the navigation, must it go

Mr. *Charles Hicks* and Others.

June 11, 1845.

from bank to bank, the river being 250 feet in width, and whatever height might be required for the vessels?—I should say at least 80 feet would be required in height.

2148. What is the state of the banks on each side?—The banks are about 10 feet high on each side.

2149. Consequently, to give height to any vessel with masts, an embankment to a considerable height must be raised?—Yes.

2150. At what distance from Rye, in a direct line, is the place where they could cross without interfering with the present navigation?—About a mile and a half.

2151. You have stated that vessels with masts could not pass if that bridge was erected; could barges such as go up to Bodiham Castle, to bring down the agricultural produce, pass? I believe they would have very great difficulty in passing until half-tide, and even then I think they would not pass. I have seen a barge carried down with the tide at flood, and another barge coming up at the same time, the current running in opposite directions; and sometimes you will see the tide setting in opposite directions, operating on the fore part of the boat, and another current abaft.

2152. Does that arise from projecting points on either side?—It arises from the eddies.

2153. (Mr. *Rice.*) Do you know the fact that this bridge will narrow the channel in that case?—They might erect bridges without narrowing the channel—open bridges.

2154. Except as to rigged vessels, if they did not narrow the channel at all, would they affect the passage of barges?—Yes. If the current set in a straight forward direction through the whole of the arches of the bridge, there would be no difficulty in passing a barge through.

2155. Supposing there were an arch and no piers, and the channel not narrowed?—Then it would not affect the current at all.

2156. (Mr. *Chapman.*) Supposing it was a draw-bridge, could not the railway be made to pass a draw-bridge?—If it were a draw-bridge all the works must be in the centre of the channel, because a draw-bridge would not contain an opening of more than 33 feet, while the distance from bank to bank is 250 feet.

2157. (Mr. *Rice.*) Supposing they gave a side opening that would give as great a facility for the flow of water up there, as far as the flow of water goes, would the erecting of a swing bridge affect it?—The flow of water would be much obstructed by the centre piers, because they must be of a massive character; and I also think they would not be able to get them to stand, in consequence of the unsound state of the foundation, without filling in on each side. If they do, the water way will be contracted to 33 feet, whereas now they have a water way of nearly 250 feet.

2158. (Mr. *Hume.*) Have you any means of knowing what the foundation at that part is?—Yes, we probed it. The bed of the river consists of alluvial matter, to the extent of at least 20 feet below the surface of the bed.

2159. How was that ascertained?—By the harbour master.

2160. (To Mr. *Stocks.*) Have you seen the bed of the river, where it is proposed the bridge should pass, bored to ascertain the nature of the soil below?—No, I have probed it with a small iron rod as far as I could get it down by hand.

2161. How far have you probed it?—About eight feet.

2162. Did you find much difficulty in going down eight feet?—No.

2163. Is it a soft boggy soil, or what?—It came up muddy.

2164. Is that below the low-water mark?—Even with low-water mark.

2165. Was that in the middle, or at the side?—Near the side. I was sounding for the platform of the tide sluice that was there formerly.

2166. How did you know of that sluice?—By reports from the barge people putting their poles on it, and pushing the bars up and down.

2167. Did you find any of those foundations?—I found the platform of it.

2168. How deep was the platform below?—About three feet from the surface of the water; about a foot and a half under the sand.

2169. Is that now there?—Yes, that is near the place, as far as I can understand, the proposed bridges are to cross the river. Any contraction of the river beyond a very great distance would be very injurious and dangerous to the barges.

2170. (To Mr. *Hicks.*) Have you, during your residence at Rye, had any opportunity of ascertaining what is the foundation in that neighbourhood below the surface?—I have; it is alluvial soil.

2171. Firm or loose?—Loose alluvial soil, sand, and mud.

2172. No bog?—None.

2173. (Mr. *Rice.*) Beach in any case?—I never found any beach.

2174. (Mr. *Hume.*) Have you any shingle to the northward and westward of the town of Rye, in the river?—None; there was formerly an old ford way.

2175. How high up is that fordway?—About a quarter of a mile. In speaking of the advantages that were derived when the sluice was up, it was stated by me that I did not conceive that the harbour was greatly improved. Mr. Stocks has stated there was water up and down. I wish to be clearly understood. At the bottom of the channel there was very little difference, but that the immense bulk of water that remained up the country continued to run down, and that gave the water in the harbour; it did not give it on the level on the bottom of the channel.

2176. (*Capt. Washington.*) Do you mean to say it did not scour out any of the channel?—It did, but not to the extent stated by Mr. Stocks. The water was caused by its coming out of the great reservoirs in the country.

2177. As far as navigation is concerned, the practical effect was that you had water up to the town at low water spring, whereas now you have a dry bank?—The water was continually running down, and therefore it left more in.

2178. (Mr. *Hume.*) At present have you any run of water past the town of Rye at all times?—Yes.

2179. What depth?—Some places not more than six or eight inches, and there are in some two feet.

2180. Does the current continue running until the flood comes in?—Decidedly.

2181. (To Mr. *Stocks.*) After the sluice had been opened for two years, what quantity of water used to flow at ebb past the town of Rye, as compared with the present?—I believe from the time the sluice first gave way it was rebuilt in two years. During that time the drain of water from the country would bring barges down light with the ebb tide at low water.

2182. Are the Commission to understand that from the sluice down to the harbour's mouth barges drawing 2 feet water could then go out at low-water?—Yes.

2183. At present no barge can go?—They are catching the ground every little way with banks.

2184. In fact, do they go now?—It depends greatly upon whether there is a run in the country, and whether much fresh comes down.

2185. If there is no ebb can they come down?—They cannot.

2186. (*Capt. Washington.*) What is the rise of tide at the town of Rye at spring tide?—Fourteen feet.

2187. What is it at the bar?—It is from 22 to 24 feet in the bay.

2188. (Mr. *Rice* to Mr. *Hicks.*) Are you largely engaged in the coal business at Rye?—Yes.

2189. Do you send a great quantity of coal in barges up the river above Scot's Float Sluice?—Yes.

2190. Where do you unload your vessels and put the coals into barges?—At Stag's Hole.

2191. Is that below the place where the proposed bridge is to be?—A great way below.

2192. Might you not, if you thought proper, unload your vessels at Scot's Float Sluice?—Yes.

2193. But you do not think it necessary to avail yourself of that advantage, and you unload them at the town?—Yes.

2194. A great many vessels go up loaded with chalk?—Yes.

2195. Are they mast vessels?—Yes.

2196. And they unload at Scot's Float Sluice?—Yes.

2197. What would be the difference of expense to these parties who now unload at Scot's Float Sluice if they were obliged to put their chalk and coals into barges below the present proposed bridge?—The expense to the chalk would be small comparatively, only there would be great inconvenience from want of room to lay it. The coal would cost one shilling a ton more at least.

2198. (Mr. *Hume.*) If the sluice was removed the vessels would go higher up?—I have no doubt they would.

2199. Have you any means of ascertaining the quantity of goods carried through the sluice up the country?—I have.

2200. What is your duty as Admiralty Commissioner; how are you appointed, and what have you to do?—I will answer that question by reading the following letter.

"Sir, "*Admiralty*, 11*th July*, 1833.

"I am commanded by my Lords Commissioners of the Admiralty to acquaint you that it is their Lordships' wish to name you a Commissioner for Rye Harbour, under the provisions of an Act of Parliament passed in the present Session, entitled 'An Act to alter and amend the Powers of several Acts passing relating to the Harbour of Rye, in the County of Sussex, and for granting further powers for improving and completing the said Harbour, and the Navigation thereof.' And I am to request that you will communicate to me for my Lords' information any thing which may concern the Admiralty.

"I am, Sir,
"Your very humble obedient Servant,
"*Charles Hicks, Esq., Rye.*" "John Barrow.

2201. You were appointed in 1833?—Yes.

2202. Have you acted since then?—I have.

2203. The difference of opinion which you express, between you and the other Commissioners, was expressed by you as the Admiralty Commissioner?—Yes.

2204. Did you make any representation at that time to the Admiralty of the difference of opinion, and the alteration that was going on?—I did.

2205. In reports?—Yes.

2206. Were these representations attended to?—I never had any answer from them. I wrote once to be instructed in my duty, to which I never had an answer.

2207. Are there any other Admiralty Commissioners authorized by that bill?—No.

2208. Does the Bill authorize only one?—Only one.

2209. If there had been a majority of Admiralty Commissioners, would matters have gone on as they have done in that harbour?—Not if they had been of my opinion.

2210. Your Act of Parliament would have prevented building up first west, and then east, and then west and then east piers?—Yes.

2211. You would have had some definite plan to go upon?—Certainly.

2212. (*Capt. Washington.*) I see an embankment across a piece of water called the Nook or Greedy Gut, to the westward of the harbour; when and by whom was that made?—In 1839 by Mr. Shadwell.

2213. What authority had he to make such an embankment?—He had no authority.

Mr. *Charles Hicks* and Others.

June 11, 1845.

2214. (Mr. *Hume.*) Who was Mr. Shadwell?—He was a man of large property living at Hastings.

2215. Had he property there?—He purchased that property.

2216. Is it under high water mark?—Yes.

2217. (*Capt. Washington.*) Does the tide flow up beyond that?—Yes.

2218. What distance? to a mile and a half?—He has made two wharfs, and it is more than a mile. The water rose at the bank three feet at high water.

2219. Over what extent?—From 200 to 300 acres.

2220. Did that water, then, amounting to upwards of 10 million cubic feet, or 300,000 tons, scour over your bar at all spring tides?—There was a great flow of water all the way round, and a great many patches of land were filled by the water.

2221. And that helped the scour at every ebb tide?—There was a great run of water out.

2222. (To Mr. *Hicks.*) Do you know under what authority that water was embanked out?—No.

2223. (Mr. *Hume.*) Did you report it to the Rye Harbour Commissioners?—No; there is Camber Castle situate on the banks, and it was stated that when that castle was built, you could throw a biscuit from the shore to the castle; Mr. Cubitt and I therefore went over, and it appears according to our calculation, that the 'fulls' or ridges of shingle advanced at the rate of one in every 19 years, from the time the castle was built.

2224 (*Capt. Washington.*) Did you report to the Admiralty Commissioners this encroachment on the harbour?—I did not report it to the Admiralty; but I pointed it out to Mr. Cubitt, because I understood it was beyond the jurisdiction of the harbour.

2225. (Mr. *Hume.*) (To Mr. *Manser.*) Do you recollect the people collecting at Rye, and the neighbourhood to destroy Scot's Float Sluice?—Yes.

2226. What year was that?—1830.

2227. Can you state the circumstances connected with it?—Proceedings in Chancery were instituted by the late Mr. Curteis, the Member, in which suit a Mr. Clarke was defendant. In consequence of that suit, the Court of Chancery directed an issue to be tried as to whether Scot's Float Sluice, as then erected, was or was not a nuisance to the navigation. That issue was tried in the county of Surrey, in order that a disinterested jury might be had; and that jury found that Scot's Float Sluice, as then erected, was a nuisance; but that, if certain alterations were made, it would not be a nuisance. A decree was made in accordance with the verdict of the jury, but the alterations were not made. Then the Commissioners of Sewers applied to Parliament, and in the preamble of their Bill, they set out that the alterations which the Court of Chancery had directed to be made were found to be unnecessary, but that other alterations might be made with greater advantage. Those alterations were made, and they got their Act of Parliament legalizing the erection of that sluice with those alterations, and the sluice was erected in conformity with it. The reason why the sluice was partially pulled down was, that the decree of the Court of Chancery had not been fulfilled within the time therein specified.

2228. What year was that?—1830.

2229. What means were taken to prevent it being destroyed?—By calling in the aid of the military.

2230. How long did the military remain there to protect it?—As near as I can judge, about a week.

2231. Was any representation made at that time to the Admiralty or to the Government on the subject?—Yes.

2232. By whom?—By the town of Rye.

2233. To whom was the application made?—There was an application made to the Admiralty; and at the time that application was made, the Commissioners of Sewers were before Parliament, endeavouring to get an Act of Parliament to authorize the rebuilding of the sluice.

2234. Can you obtain a copy of that representation from the archives of the town of Rye?—I do not know that there is any copy; I think among the Admiralty archives it would be found.

2235. Notwithstanding that representation on the part of Rye, the Commissioners of Sewers were allowed to get their Bill, and erect the sluice without carrying out those improvements which the jury had pointed out?—Yes.

2236. Since then, have any complaints been made on the part of the inhabitants of Rye against it?—I have not heard of any.

2237. The Act of Parliament, you think, settled that?—Yes.

2238. (Mr. *Rice.*) (To Mr. *Manser.*) When those embankments were enclosed, did the Harbour Commissioners receive any compensation from the parties enclosing it for the value of that land?—They received nearly 7000*l.* altogether.

2239. At how much per acre?—There was a standard of 14*l.* 10*s.* an acre fixed, and the other land was valued in reference to that.

2240. Was the expense of making the embankment partly defrayed by the harbour dues?—It was paid out of the money which the Harbour Commissioners received for compensation. The harbour dues remained untouched.

2241. (Mr. *Hume.*) Was the whole of that 7000*l.* applied to raise the embankment?—Not the whole of it; some portion of it was left.

2242. What became of that?—It was invested on mortgage.

2243. (*Capt. Washington.*) Are the Commission to understand that the Rye Harbour Trustees were consenting parties to the erection of this embankment, which you have admitted, enclosed upwards of 700 acres of marsh, covered to the depth of three feet at spring tides,

thereby excluding above 30,000,000 of cubic feet, or 870,000 tons of water, and losing its scour on each spring tide?—Yes. Mr. *Charles Hicks* and Others.

2244. (Mr. *Rice.*) A part of that arrangement was to receive compensation at so much per acre?—Yes. June 11, 1845.

2245. (Mr. *Hume.*) Were any of those Commissioners proprietors of the adjoining land?—Three of them.

2246. All influential proprietors in the neighbourhood?—Yes.

[*The Witness withdrew.*]

Adjourned till Friday next, at one o'clock.

Friday, June 13th, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Mr. HUME, M.P.	Mr. GODSON, M.P.
Mr. RICE, M.P.	Captain WASHINGTON, R.N.
Captain BEAUFORT, R.N.	

Mr. *James Walker*, C.E., sworn and examined. Mr. *James Walker.*

June 13, 1845.

2247. (*Chairman.*) There has been referred to this Commission by the Admiralty for our opinion, the question of the proposed bridge of the Glasgow Junction Railway over the Clyde, and to report as to the site and dimensions; will you be so good as to state its site and dimensions?—They would be better stated by the engineer to the Bill. But I am enabled to say that it is proposed to erect two piers, each about 15 feet wide, in the Clyde, and to carry a single line of rails upon them; the distance from the present Glasgow Bridge to the face of the new pier being 47 feet, and the breadth of the bridge 16 feet.

2248. What is your opinion as to the general effect of the proposed bridge on the navigation of the river?—The principal effect is taking about 60 feet from the present harbour, the height being such that the mast or funnel of a steamer cannot get under it, but which the stem of a steamer may get under. The height of the middle arch is from 30 to 35 feet above high water, and the spring of the arch will be about 22 feet above high water. A little way above the proposed bridge is the Glasgow Bridge which has six piers, the average of which is 8 feet 6 inches, therefore the present piers take up 51 feet, and the proposed bridge will take up 30 feet of the water-way; but the piers being 15 feet, and opposite to piers which are 9 feet, form at that point a greater obstruction than one of the 9 feet piers.

2249. (Mr. *Hume.*) What portion of the shipping trade is carried on above the proposed bridge?—It has been given in evidence that the steamers at present come close up to the bridge, and that these piers will be an obstruction to their lying so near to the bridge as they now do, and also to their turning. I have no doubt that is the case, at the same time I must freely confess, that although taking off that piece of the river diminishes the length of the harbour of Glasgow, if it were a very important object to cross the river by such a bridge, which I do not think it is, the harbour interest perhaps ought to give way to the land interest.

2250. (*Chairman.*) Are you aware of any way in which this inconvenience may be avoided altogether?—Yes; I suggested to the Committee that the inconvenience may be avoided by not crossing the river at all, nor (which is certainly in my opinion the greater evil) going through the city and through the very best part of Glasgow, and under it, by leaving the Glasgow and Ayr Railway, before entering the town. The difference of distance is two miles and a half, but the resistance is not in that proportion, because the difference of level between the point of starting and the summit, are in both cases 151 feet, and the gravity up and down has more to do with it than the horizontal resistance or friction.

2251. (Mr. *Hume.*) Where then would you propose to cross the river, to get to the point in the north?—A quarter of a mile above Rutherglen Bridge.

2252. Is any navigation extended beyond that point?—No, only for boats; and the lift of tide there is very trifling indeed, perhaps not a foot.

2253. Consequently if other impediments in the river below were removed the new line would not at all prevent the improvement?—No.

2254. (*Chairman.*) Are you aware of any intention of taking away the new Glasgow Bridge for the purpose of improving the navigation of the Clyde, and of enabling vessels to come higher up the river?—I never heard of it till this instant.

2255. Do you think it would effect it?—It is practicable, but I do not think it at all expedient. The space between the present Glasgow Bridge and the Stockwell Street Bridge is being formed (which complies with a report I made many years since) into a basin or harbour for river boats and small craft which come under the bridge.

2256. (Mr. *Hume.*) For extending the harbour accommodation for small vessels and leaving below that bridge the larger?—Just so. I do not consider that the two piers, in preventing the tide getting up into the country are of much, or indeed any consequence; in preventing the land floods getting off their obstructing the fair current would have more effect, but this also would be small.

2257. Would not these two piers, by coming opposite the piers of the bridge above, be to a certain extent, an impediment to the flow of the tide?—Practically they would not, the velocity of the tide being small.

[*The Witness withdrew.*]

Mr. *John Miller.*

June 13, 1845.

Mr. *John Miller*, Civil Engineer, sworn and examined.

2258. (*Chairman.*) You are engineer to the Glasgow Junction Railway Company?—Yes.

2259. Have you a plan relating to the proposed railway passing through the town of Glasgow and over the Clyde?—I produce the Parliamentary plan of the whole scheme, showing the crossing of the Clyde, both in line and elevation.

2260. Whereabouts is it proposed to cross?—Below, or to the west of the new Glasgow Bridge. It is 57 feet between the west side of that bridge and the centre of the proposed railway.

2261. How many piers do you propose?—Two piers in the river, and each pier is proposed to be 15 feet wide. The height of the arches is 36 feet 6 inches over what we have stated as the high water. I have been led to understand we have stated the high water three feet too high. If so, the height would be 39 feet 6 inches above high water, but the high water which I have assumed being in a river the high water is not very permanent in its rising. I have taken in 33 feet 6 inches in the cowl of the arch.

2262. (M. *Hume.*) What will be the height at the spring?—The way in which it is proposed to place the piers is, that they should expand with three arches, having a wharf on one side, or rather a wharf on both sides, under the centre, or nearly under the centering, of each side arch. The middle arch stands entirely in the water. The two side arches are partly over the water, and partly over the wharf. The rise of the arch is 14 feet.

2263. What is the clear water-way from quay to quay?—The clear water-way at that part of the river is 430 feet.

2264. You propose to take off by the two piers 30 feet from the water-way?—Yes: 15 feet occupied by three piers, and placing these piers immediately in the line of the piers (which are smaller) of the existing bridge. The existing bridge, I think, has six piers, running from 8 to 9 or 10 feet, averaging, I believe, about 8 feet 6 inches. This scheme is proposed to place two piers, and to have each of these piers, though wider, placed in the same line of current, as it were, of the existing piers.

2265. If that was erected, there would be two parallel bridges, with a distance between them of 57 feet?—Yes.

2266. Would not the railroad in that case interfere with all horses and carriages, and everything passing so near?—No; it is elevated; our bridge stands about 20 feet above the present bridge. It is a cast-iron bridge, and it is proposed to put up an iron railing on each side, and to construct that so as to form a screen, by which trains passing along the bridge would not be observed by horses or animals.

2267. What kind of pier do you intend to make?—A stone pier.

2268. Have you tried the foundation?—Yes; it is sand to a great depth.

2269. Do you know how deep the foundation of the bridge next to it was carried?—The piles, I think, are from 12 to 15 feet. The present bridge, which was built by Mr. Telford is founded on the sand, and it is proposed to follow the same plan.

2270. There would be, then, no difficulty in deepening the river in that part, if it is simply of sand?—The only difficulty is, that if it were deepened beyond what it now is, it would affect the present bridge.

2271. Do you intend to put the piers immediately below or in the same depth as the present bridge?—About the same depth; so that any deepening of the river that could be effected in consequence of the present bridge, could be done, supposing our bridge was erected.

2272. Have you seen any plan by Mr. Bald, for deepening the river considerably upwards, so as to admit vessels of a larger description than now go through the bridge?—I have not. I understand from Mr. Walker, that the extreme depth proposed there is 16 feet, which is below the bridge. That depth cannot be made above there, in consequence of the other bridge; but the bridge we propose will admit of the river being deepened to the fullest extent Mr. Walker contemplates by the present bridge.

2273. What is the distance between the bridge adjoining yours and the next stone bridge above?—The distance between the Glasgow Bridge and the Stockwell-street Bridge is about 500 yards.

2274. (*Capt. Beaufort*) Would there be any difficulty in carrying the railway above all those bridges?—The town intervenes; the very dense part of the town immediately comes on above the bridge at the north end.

2275. Would there be any great difficulty in carrying it above the town?—The bridges go up above the top of the town.

2276. What would be the difficulty?—The difficulty is a great increase of line, and not answering the purpose of making it a thorough line. The new line would require to be made longer by about six miles, according to the scheme Mr. Walker has proposed; but that is not the objection to it. The objection is, that it takes the whole traffic round from Glasgow, and breaks it up so as to be, in my opinion, no public advantage whatever. Allow me to add, our three arches occupy a space of 520 feet; off that there is 30 feet of pier; therefore our three arches occupy 490 feet.

2277. (*Capt. Washington.*) Can you state the height of the soffit of the present Glasgow Bridge?—I think it is not more than 15 feet.

2278. (*Capt. Beaufort.*) What is the proposed span of the centre arch?—180 feet; two piers of 30 feet, and a side arch of 150 feet.

[*The Witness withdrew.*]

Adjourned to Wednesday next, at One o'clock.

Friday, June 27th, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir G. BREMER, K.C.B.	Mr. RICE, M.P.
Mr. HUME, M.P.	Captain WASHINGTON, R.N.
Mr. GODSON, M.P.	

Capt. Edward Holland, R.N., sworn and examined.

2279. (*Chairman.*) You are a Commander in the Navy, and reside near Truro?—Yes.

2280. How long have you been in the Navy?—Since the beginning of the year 1814.

2281. Are you well acquainted with the harbour of Falmouth?—I am well acquainted with the inner harbour.

2282. Will you state whether within your knowledge any changes have taken place in the state of that portion of the harbour with which you are acquainted?—I should say there are none of that particular portion of it, except where quays or wharfs have recently been built. One or two wharfs have been built. A wharf belonging to the tan-yard at the upper end of the creek, and a small wharf near Glasson's quay.

2283. Are you aware of any decrease or increase?—Not of my own knowledge. I am aware that a very large quantity of sediment is brought down from the mining districts into Falmouth Harbour.

2284. (*Capt. Washington.*) Will you state whether any change is taking place in any of the creeks or branches of Falmouth Harbour?—A change is taking place in Restronguet Creek, owing to the drainage from the mines.

2285. (*Chairman.*) Where do you apprehend that drainage deposits itself?—Chiefly off Milor Point, where the water is decreasing. I do not know that so much from my own knowledge as from having conversed with one of the best and oldest pilots there.

2286. (Mr. *Hume.*) Who has the charge of Falmouth Harbour; under whose authority is it?—The corporation of Penryn claim authority in right of being lessees of the Bishop of Exeter; they exercise jurisdiction over one portion of Penryn Creek; the corporation of Falmouth again exercise jurisdiction over another portion.

2287. How far is the River Fal navigable from Restronguet point?—To Truro.

2288. Who has the charge of that navigation from Truro downwards?—The corporation of Truro claim a portion of it; the corporation of Falmouth exercise jurisdiction over another portion; and the corporation of Penryn over another portion.

2289. (Mr. *Godson.*) Do they claim that under Act of Parliament, or under Charter?—I believe by prescriptive right. I have in my possession an Act of the 22nd and 23rd Charles II., (A.D. 1670,) for building a church, in which reference is made to power given to the proprietors to erect gates, and carry them as far out as they please.

2290. (*Capt. Washington.*) Is there a harbour-master at Falmouth?—No.

2291. (Mr. *Hume.*) Is there any officer having charge of the general navigation of the harbour of Falmouth?—None.

2292. (Mr. *Godson.*) Are you now before Parliament to obtain any Act of Parliament respecting the water at Falmouth?—Respecting a portion of it; we limit our control within certain limits.

2293. What Act of Parliament is it you are seeking?—For the improvement of Falmouth Harbour.

2294. Will you state shortly what are the improvements you intend or wish to make under that Act of Parliament?—To construct a floating harbour in Penryn Creek.

2295. (Mr. *Hume.*) How high does the tide flow above the place where you propose to erect a dock?—Nearly a mile, I think.

2296. Is it navigable from there upwards now to Penryn?—Yes.

2297. What sized vessels, and of what draft of water proceed to Penryn?—Vessels drawing 13 feet water at spring tides, can come up to the town quay.

2298. Will the navigation up to that length, therefore, be stopped during the time sluices are opened?—Yes.

2299. At what rate does the current flow at that spot at present?—Near low water; when the water has left the shoal banks the water runs out pretty quickly.

2300. Will the formation of that embankment across stop the influx of the tide?—It will.

2301. May not that want of scour injure the depth below?—No, it will improve it very much, because we have a very great back water. If I were asked the question what would be the best mode of keeping the inner harbour clear, supposing it did silt up, I should say I would construct this embankment, and by that means have the back water to let out at low water.

2302. Have you ever seen the operation of the sluice back water being applied to clear out?—I have seen one at Hayle, a small but thriving port in St. Ives' Bay, on the north coast of Cornwall.

2303. Have you seen that at Shoreham?—No.

2304. Are you aware that every back water, when let out, causes a hole, and almost immediately loses the strength of sweeping off any of the deposit?—I am aware that is so if you do not form an apron; but if you carry out an apron it will not do so.

2305. To what extent and in what form would you carry out the apron?—I think I should carry it out nearly upon a level.

Capt. E. Holland, R.N.

June 27, 1845.

2306. To what distance?—That is an engineering question; but I think I should carry it out about 150 feet.

2307. Have you ever seen the back water formed at Dover?—No.

2308. Have you heard that that has failed to have any effect?—I have heard that it has not answered fully.

2309. Has any instance come to your knowledge where a backwater of that sort has had any effect in clearing the channel?—Yes.

2310. What case?—In the case of Hayle it has deepened the channel six or eight feet, and maintains it at that depth. Two Companies have taken the control of that harbour upon themselves, and they have improved it vastly, without reference to the Admiralty or any other body.

2311. What Companies do you allude to?—One is the Copper House Company; I do not remember the name of the other Company.

2312. Are you aware whether they have acted under any Act of Parliament, or with the sanction of the proprietors of the soil?—With the sanction of the proprietors of the soil.

2313. What sized vessels are admitted into Hayle?—Vessels of 200 tons can go in now.

2314. A dock has been made into which they are admitted?—No; merely by the effect of sluicing they have deepened the channel. There is no floating dock.

2315. Is it your opinion that by blocking up the river in Falmouth inner harbour, and making a floating dock, the channel will be deepened better than by admitting the regular flow of flood and ebb?—I think we shall be able to maintain the depth of water just as well as it is now maintained.

2316. In what way do you propose to maintain the channel to its present depth?—By sluicing. Mr. Rendell's report of the 6th December, 1844, states what is proposed to be done.

2317. To what distance does he propose to deepen the channel beyond the sluice mouth?—About a quarter of a mile.

2318. Has that Act been passed, or is it in Parliament?—It is now in the House of Lords.

2319. Has any application been made to the Admiralty for permission to do that?—Yes, we have their consent.

2320. Has the consent of the town of Penryn been given to block up the navigation by these docks?—I should say their consent has not been given as a corporate body; but the merchants and a large majority have consented. We have a petition to the Admiralty, signed by 476 of the people in Penryn, which includes, I believe, all the adult population.

2321. You are of opinion that the upper part will not fill up?—Yes.

2322. What is the nature of the soil in the channel from Penryn to the dock?—Mud.

2323. Will the space from the docks to Penryn be kept full of water?—Yes, always.

2324. Will it not silt up?—I think not.

2325. (*Capt. Washington.*) Does not all the refuse of the town of Penryn drain into it, as well as the drainage of two small streams?—That is very trifling.

2326. What depth of water is there now up to Penryn?—13 feet at spring tides at the Town Quay.

2327. Is it not dry at half tide?—Yes.

2328. (*Chairman.*) What is the rise and fall?—18 feet on an average.

2329. (*Mr. Hume.*) Then that flow and ebb will be prevented if the space is always to be kept full?—Yes.

2330. In what way will your sluice in that case be useful to clear the lower part of the river?—By waiting till nearly low water, and then letting the water out through sluice-gates; to let it run out in a strong stream near low water, and probably to use mechanical aid to stir up the bottom.

2331. Is it proposed to let the sluice out, and leave the harbour dry?—No; only to certain limits. This is an enormous body of water, about 150 feet. Sluice-gates could not be constructed to let the tide out in one tide.

2332. Will not that show that the quantity of ebb prevented is very great?—Yes; but the engineer states in his report, that he has come to the firm conclusion that that will not injure it. He has taken that point particularly into his consideration.

2333. Has it been well considered whether a deposit will not take place from a dock up to Penryn, where it appears that the ebb will be prevented from flowing?—I have considered it; I think there would be less deposit than there was.

2334. Are you not aware that, from the streams flowing down by Penryn, considerable mud and water must be collected?—No; I am aware that they are particularly clear; they rarely have any sediment in them at all; those streams are as clear as crystal.

2335. Do you speak of the ordinary stream or after flood?—Of the ordinary stream.

2336. Does it not appear that whatever comes down must form a sediment, and cannot be let out?—Yes.

2337. Will not that fill up the channel from the dock up to Penryn, and thus stop the navigation to Penryn?—No, I think not. When the sea sets in, it causes a little rush up even to Penryn. I have known vessels there moving so much that they could not put the granite blocks on board, owing to the movement of the vessel. The result is, that it causes a wash all along the shore, and that breaks away the clay-slate, of which the banks are composed, which falls down, and becomes mud.

2338. Will not a heavy flood from the land in the same manner bring down portions of earth and mud, and there being no outlet, will it not necessarily be deposited in that basin?—Yes.

2339. In a few years will not that have a sensible effect on the navigation up to Penryn?—Not more than it does at present. *Capt. E. Holland, R.N.*

2340. Why should it not go out with the tide?—It does not; we find there is no mud below. June 27, 1845.

2341. (*Chairman.*) What depth of water will there be in the proposed basin?—Nineteen feet at neap tide, leaving the four feet between neap and spring tide to use as a scour.

2342. (Mr. *Godson.*) Is this making of the dock, and the cutting off of a mile and upwards of tidal water connected with bringing down a railway to that spot?—It is in connexion with a railway; it is with the hope eventually of making a great steam packet station of the basin.

2343. (Mr. *Hume.*) How far from that do the packets now lie?—About a mile and a-half, in Carrick Roads.

2344. Why not carry the floating dock down to opposite Carrick Roads, where there would be deep water?—Because there would be too much sea. The vessels must lie out in Carrick Roads, which is far from the shore.

2345. Could not a wharf or quay be formed opposite there nearer deep water, without interfering at all with the tidal flow up to Penryn?—No; not for any vessel to come to it with safety.

2346. (Mr. *Godson.*) Has there been any opposition to this Dock Bill and Railway Bill?—There is opposition to the Railway Bill; but this is distinct from the Dock Bill; there has been opposition to this Bill also, but that is now withdrawn.

2347. (Mr. *Hume.*) By whom is this dock to be established?—It is vested in certain Commissioners.

2348. A Joint Stock Company?—No; a public Trust.

2349. By whom?—The Commissioners are taken from the neighbourhood; a certain portion of the Commissioners from the borough of Penryn, a certain portion from the borough of Falmouth, and others from the parishes forming the boundary, and also from those parties who may advance the money to carry it out.

2350. In what way are the funds to be provided?—By whoever will lend them. It is like a turnpike trust. When we have this Act, we shall go to the railway, and say, "Will you advance the money for the purpose of carrying these works into effect;" they will take it into consideration, and probably find it their interest to do so, and will lend the money.

2351. At what time of the tide do you calculate that the packets will be able to sail, supposing they adopt your basin as a place of rest?—At all times, I think. I think at the lowest state of spring tide there will be rarely a case when they cannot sail. It is intended to make 13 feet water at the lowest spring tide in the channel leading up to the dock.

2352. At that spot where the dock-gates are to be placed, what is the depth of water at this time?—At low-water it is dry.

2353. In what way will the packets be able to leave except at high-water?—Under our Act we dredge the tidal basin, just without the proposed floating dock, to 13 feet.

2354. Are the gates of the tidal basin to be sunk 13 feet below the present level?—One of them; the other will be about 8 feet.

2355. Will not the opening of that gate to admit the sailing of packets at low-water or half-tide empty the basin above and leave the larger vessels dry?—No; we place locks between, and lock the vessels up and down.

2356. What size are these locks?—The largest vessels that are constructed can come in,—the "Great Britain" steamer, or any of the West India Mail steamers.

2357. Is the work commenced, or about to be commenced, solely for the accommodation of packets?—Chiefly for their accommodation. Of course we expect that a great trade will come in consequence, if we get these packets.

2358. (*Capt. Washington.*) In the Harbour Trust that you have mentioned are there any sailors?—Several.

2359. Is the harbour of Falmouth efficiently lighted and buoyed?—It is efficiently lighted. It is not buoyed, nor is it essential it should be. If the improvements now before Parliament should be carried out, I should suggest that the channel up to the docks be well buoyed, and a harbour light, not visible from sea, be placed at the entrance of the tidal basin.

2360. From your knowledge of the coast of Cornwall and the Bristol Channel, will you state if there is any want of lights, beacons, or buoys?—I am not sufficiently acquainted with the navigation of the English or Bristol Channels to offer an opinion.

[*The Witness withdrew.*]

Daniel Mackain, sworn and examined. *Daniel Mackain.*

2361. (*Chairman.*) What is your profession and place of residence?—Secretary and engineer to the Glasgow Water-works Company, and residing near to Glasgow.

2362. You are desirous of making some statements with reference to any removal of the weir in the river Clyde?—I wish to state that the Glasgow Water-works Company have acquired a right of protection, by means of the weir now existing, from the injury that would result to them if the low-water at their works were reduced to the low-water level of the navigable channel further down, not merely by a decision of the Court of Session after considerable litigation, but also by an express clause in an Act of Parliament.

2363. (Mr. *Hume.*) What is the Act of Parliament which authorizes you to throw a weir across the river Clyde?—The Acts of Parliament direct the Trustees of the Clyde Navigation, in 1825 and 1840, to execute works for the protection of the Glasgow Water-works.

Daniel Mackain.
June 27, 1845.

2364. What Act authorized the Glasgow Water-works Company to throw a weir across?—The works are not done by the Glasgow Water-works Company.

2365. Can you furnish the clauses under which the works have been executed?—Yes.*

2366. Did the Water-works Company pay the Clyde Navigation Trustees any money for that?—None. The Glasgow Bridge, which formerly existed at Jamaica-street, was built shortly before the works for improving the navigation were commenced. The operations under the Act of Parliament were commenced about 1775, and that bridge was built at that time. In 1778 the channel of the river was so lowered by these operations that the foundations of the bridge were undermined, and the weir became necessary to preserve the bed of the river at the bridge from being further deepened.

2367. How far are your works above that bridge?—Two miles.

2368. What height is the weir?—The weir is level with the original bed of the river, but the navigable channel below has been lowered by the operations of the Clyde Trustees about 9 feet.

2369. If the weir were removed the channel might be deepened above as below?—It would be deepened to a certain extent.

2370. Is there any navigation that comes up to that weir?—None.

2371. Does the tide flow over it or rise to it?—The neap-tides scarcely go over it, but the spring-tides go 3 feet over it.

2372. At low-water is the bed of the river dry at its foot?—On the side next Glasgow it is dry.

2373. Are there any vessels which come up during high-water near to the weir?—They come up to an extension of the harbour which has been made immediately above Glasgow Bridge.

2374. Through the Glasgow Bridge?—Yes.

2375. How near are your works to Rutherglen?—The Cranston Hill Water-works, which is one of the water-works now forming part of the Glasgow Water-works, is immediately opposite Rutherglen, and the other water-works is one mile above it.

2376. What sized vessels have you seen come up to Rutherglen?—Two (2) punts.

2377. How long have you been engineer to the works?—First of all to the Cranston Hill Works, and, secondly, to the Glasgow Water-works, for 16 years.

2378. Are you aware that Rutherglen was the original port of the Clyde?—No. I had an opportunity of hearing the evidence of some very old men, during the investigation of the question as to the navigation that formerly existed to Rutherglen, before Commissioners appointed by the Court of Session.

2379. In what year was that?—In November, 1841.

2380. Where is there a copy of that evidence?—It is in a process that was carried on at the instance of the magistrates of Rutherglen against the Clyde Trustees and the Bridge Trustees; and the Glasgow Water-works Company were conjoined for their interest.

2381. What was the title of that process?—It was a process originally raised at the instance of the Duke of Hamilton and the Magistrates of Rutherglen against the Bridge Trustees and the Clyde Trustees, to remove the weir. It was commenced in 1807. It lay in abeyance from 1807 to 1834. At that time the Clyde Trustees and the Bridge Trustees proposed to remove this weir. The Water Company objected to it on the ground that it maintained the level of the river at low-water at its natural height, and that, until some other substitute was provided to preserve the water at the same level at the water-works, they would object to its removal. The litigation was carried on until 1841, when it was settled by a joint minute subscribed by all the parties, and a remit was made in consequence to Mr. Walker of London and Sir John Macneil to construct a new weir at Stockwell-street Bridge further up the river.

2382. How much farther up?—About 500 yards.

2383. Was that done?—Yes.

2384. And the old weir taken down?—Yes.

2385. Does your evidence as to the rise of the water apply to the new weir or to the old one?—That of which I have spoken is the new weir.

2386. Then are the Commission to understand that no tide flows beyond your present weir?—The high water of ordinary neap-tide does not, but high-water spring-tide does flow over.

2387. How high beyond that does it flow?—We feel the spring-tide rise, that is to say, we feel the river swell up at the Glasgow Works, which is very nearly two miles above it, but there is no stream upwards, merely a swell of the river, occasioned by the slope of the surface of the water being lessened.

2388. Is the Rutherglen Harbour above or below the new weir?—Above.

2389. Then there is no admission to Rutherglen but by small vessels which can come through the bridges?—None; nor has there been since 1345. I would add, that the same navigation exists now that ever did to Rutherglen, with the single exception that at low-water the weir is a fixed barrier; at high-water there is the same depth above the weir that ever existed.

2390. Can the vessels in going to Rutherglen cross the weir?—At high water they can.

2391. Over the top of the weir at high water what depth would you have at the highest tide you have ever seen?—I cannot say positively, but my impression is, that in the highest tide there might be upwards of three feet.

2392. At that time what would be the depth of water below the weir?—12 or 13 feet.

2393. If there was no weir vessels drawing 12 or 13 feet water could go up to Rutherglen

* See Appendix, p. 152.

at high water?—They might, but the cause of this great depth below the weir has been the operations of the Clyde Trustees in dredging out.

2394. Might not the trustees dredge it above in the same manner if the weir were removed?—They might, on obtaining powers under an Act of Parliament; but the point where the weir has been placed is the upward limit of the field of their operations; but there are many very important considerations which must be regarded. In the first place, there are several very valuable factories that are above the weir which draw their water from the river. If the water were lowered, at low water they would be put to the inconvenience of not being able to draw water for their engines and purposes of their works, which forms the staple trade of Glasgow, during the time of low water.

2395. Is not the navigation in that point of view put to an inconvenience by not being free?—I am not aware of any advantage arising from the navigation. The navigation that existed to Rutherglen in the olden time, according to the evidence of the old men to whom I have alluded, existed in consequence of the bad state of the roads by land. At that time coals were brought into Glasgow in sacks on the backs of horses, and whenever it came on bad weather, the roads not being paved, the horses stuck in them. When the roads were afterwards improved the navigation ceased entirely, because, according to the evidence of one of these men, it was only a little further to drive coals into Glasgow from the coal hills after they were once put on the cart, than to drive them down to Rutherglen.

2396. Have not all these circumstances changed by there being good roads and improved navigation?—Yes, as regards the roads, but the navigation remains as it was.

2397. Are you aware where it is proposed to cross the Clyde by the route of the new railroad?—I am not; I have heard that it is to cross the Clyde near the Cranston Hill Water-works.

2398. That is to the eastward of the Cranston Hill Water-works?—Yes.

2399. How far?—I do not know.

2400. If the railroad should cross the Clyde anywhere to the eastward of that weir, would not the communication between the railroad and the river be stopped by the weir?—The weir is now proposed to be reconstructed about 140 yards above Hutchison's Bridge, and a lock or other work is to be put into it to connect the upper with the lower navigation. To the extent of communication that this lock will afford, the navigation will be opened.

2401. What objections are there to moving the weir a mile and a half up above Rutherglen?—The interest of several factories and the water-works. But we do not object to any position of the weir, provided it were put below the water-works.

2402. Have these manufacturers, whose interest you speak of, any Acts of Parliament securing to them the water from any particular part of the river?—The Clyde Trustees are bound to compensate them in the event of removing the weir. In the Clyde Navigation Act of 1840, it was provided that the weir should be removed to some point below the water-works; but, in order that those parties should not be a total barrier to the removal of the weir above them, it was provided that they shall be compensated in some manner.

2403. If the navigation was required from the weir up to Rutherglen, there is no objection further than the claim of the Water-works Company and private companies to compensation for loss?—Precisely.

2404. Then that compensation would require some means by which the water should be supplied?—Yes.

2405. Are you aware from your own knowledge from what distance above Dalmarnock the water might be brought by canal, independent of the river, to your water-works?—In 1839 I recommended the Directors to bring down a supply of water from Carmyle, about two or three miles above Dalmarnock. We brought a Bill into Parliament to obtain powers to do so, in 1840; we were met in the first place by objections on the part of the proprietors and coal-owners; we wanted to convey the water as cheaply as possible, either by a brick or stone culvert; they objected to this because they said it would send water down on their coal workings, and they required us to be responsible for the whole increase of water they might find in the mines after the works were executed. To meet that objection we proposed to convey the water by a cast-iron pipe, but that was not considered satisfactory, and the agent of the Duke of Hamilton wished that we should make a canal, which would be fit for navigation. The Water Company considered that so objectionable that they refused to accede to it. The Bill was lost.

2406. Did you form any estimate of the expense for which a sufficient supply of water could be brought from Carmyle to where you now are?—I think some where about 50,000*l.*

2407. Are you able to say whether the work could now be done for that estimate?—I think it could be done for less.

2408. Would that supply all the water that would be required for the town and these manufactories also?—I did not take the manufactories into calculation, but merely looked to ourselves.

2409. Is there anything to prevent the manufactories pumping up to a reservoir whatever quantity they might want out of the river, supposing it free?—Nothing beyond the expense.

2410. Are there any other objections to removing the weir?—There is the injury it would do to the public green, to the health and enjoyment of the population. The Glasgow Green is surrounded by parts of the town which are occupied by the poorer class of people. On fine Sundays they go upon the Green, to the number of several thousands. If you remove the weir further up the river than it is now intended to be, the sewerage of the town, containing all the waste of the manufactories, and all the warm water of some hundreds of steam-engines, will keep playing up and down and past the Green, and vitiate the air in the immediate neighbourhood of the river.

Daniel Mackain.

June 27, 1845.

2411. What is the rate of the ebb opposite there?—In summer and in low states of the tide you can scarcely observe any current going down. I have ascertained that the quantity discharged by the River Clyde in the lowest state of summer water does not exceed 100 cubic feet in a second.

2412. Is it not clear from your evidence, that if the weir was removed and the channel deepened above as it is below, that a volume of water equal to 9 feet in depth would sweep up and down every tide, and carry away any refuse of that kind?—That which goes up and down by the tide will be in summer principally the drainage of the town.

2413. Is it not more likely to be stagnated by a weir that stopped the ebb and flow than if it was cleared?—At present, in low states of the tide, the whole water that goes down is that which flows down from the higher grounds and passes over the weir; the water above is comparatively pure to what it is below. If you go down the river in a boat below the weir, where you are near the surface of the water, the smell is most offensive, as the water for some miles down consists mainly of the sewerage of the town.

2414. From your knowledge as an engineer, would not the flow up and down make the water purer than it is now?—I do not think so; it would not be such pure water.

2415. To what extent do you consider the rapidity of the river would be increased by removal of the weir?—I have found that since the Clyde has been opened up below the harbour by dredging and clearing away a contraction in the river that existed formerly below the Glasgow Bridge, that in our heaviest floods the Clyde has increased from four and a-half miles to about six miles per hour, near to the water-works. If the weir were removed, the river would, to some extent, deepen its channel above the point where the weir is now constructed; and in proportion to the extent of additional area acquired, the current of land-floods would be slower at the part so widened and deepened than under the same circumstances it would be at present, always supposing that the lower stages of the river are to remain in their present state; but in any part of the river above this deepened part where the channel might retain its present section, the removal of the weir and the deepening of the channel upwards would have a tendency to increase the current during land-floods. In heavy land-floods the tide has no influence on the surface of the river at the water-works. To the best of my recollection, aided by diagrams frequently made of the wave of floods, it does not produce any effect on floods of even 6 or 8 feet of elevation. If the weir were removed, and the lower stages of the river sufficiently widened and deepened to allow the wave of tide to affect the surface of the river at the water-works during heavy floods, to the extent of several feet, the current of the river, with a falling tide, would be so rapid as to be incompatible with its continuance in its present tortuous channel at and above these works, and much injury would ensue from the change of the channel of the Clyde to the owners of minerals near to that river. For some distance above Glasgow the valley of the Clyde rests on a bed of liquid mud, of from 40 to 60 feet in depth, covered with a crust of sand and gravel, only some feet thick; consequently, any attempt to confine the river to its present channel, with a current greatly increased in rapidity, would be almost endless labour.

2416. (*Capt. Washington.*) Can you state the mean annual discharge of the river Clyde—the discharge per second in the largest freshes, and also in its lowest state?—I have not yet calculated the mean annual discharge of the Clyde, but have caused observations to be made several times a-day of the height of the river, and I have tried the rapidity of the current at the different elevations of flood, in order to calculate the mean discharge. These observations have been taken for the last seven years. In the lowest state of the river, the quantity of water in the Clyde passing the Glasgow Water-works does not exceed 100 cubic feet per second, while a flood 18 feet in depth discharges about 35,000 cubic feet in the same time. The flood of February, 1831, rose 20 feet at the Cranston Hill Works, opposite to Rutherglen.

2417. Are you not aware that both the well-known engineers, Telford and Jardine, engineers to the Edinburgh Water-works, reported and gave it in evidence, "That if the bottom of the ford at Dalmarnock Bridge be secured, so that its present level remain undisturbed, the weir may be taken away at Glasgow Bridge, and the Clyde deepened between Dalmarnock Ford and that bridge for about 6 feet, without, in their opinion, doing any injury to the Glasgow Water-works?"—In May, 1825, Mr. Telford, as engineer for the Clyde trustees, stated to the Committee of the House of Commons, that if the bottom of the ford at Dalmarnock Bridge be secured, so that its present level remain undisturbed, that the Clyde might be deepened 6 feet from the Broomielaw Bridge up to the south-east extremity of the public green; and that a part of the scheme for which the Bill then in Committee sought powers to execute was, that the weir at the Broomielaw Bridge should be maintained at the height it then was, and that the upper and lower navigations should be connected by a lock, passing through that weir. Mr. Jardine went further, for he said (always, it may be presumed, under the same conditions) that the deepening might be carried up to Dalmarnock Bridge; but it will be seen by the clause in the Act (*see* Appendix) that it was a part of the design that the works should "be conducted on such a plan as neither to raise nor lower the surface of the river Clyde at low water above the new bridge of Glasgow;" and from the evidence it will be seen that the deepening here referred to was merely the excavation of a channel about 30 or 40 feet wide in the bed of the river.

[*The Witness withdrew.*]

Adjourned till Wednesday, 2nd July.

Wednesday, July 2nd, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir G. BREMER, K.C.B.	Mr. GODSON, M.P.
Mr. HUME, M.P.	Mr. A. CHAPMAN, M.P.
Captain BEAUFORT, R.N.	Captain WASHINGTON, R.N.

Capt. John Fisher, R.N., sworn and examined.

[*Capt. Bullock's Chart of the River Thames, on the scale of* 20 *inches to the statute mile, made in* 1831, *was laid on the table.*]

2418. (*Chairman.*) What is your profession and place of residence?—I am a Commander in the Royal Navy, principal Harbour Master of the Port of London, and reside at St. Katherine's.

2419. How long have you been acquainted with the River Thames?—I have held the situation of harbour master 26 years.

2420. Are you aware of any obstacle to the navigation from shoals or hards in the bed of the river that might be removed with advantage?—A considerable shoal was formed about 200 feet below London Bridge, 75 feet of which was dry at spring tide; other shoals were created by the fall of water from the bridge; there were 10 or 11 feet water from the bridge; the bridge formed such a dam that it cleared every thing away.

2421. You speak of the old London Bridge?—Yes; where it was dry ground I have made a depth of 11 feet water, which is done by the Corporation of London, assisted by the Trinity House. We have generally lighters at work in the centre of the river, in order to make it from 13 to 15 feet. When we find any little accumulation we clear it away immediately; but since the steam-boats have been running at low water it has preserved the channel; in fact, the navigable channel of the river has rather increased from the action of the steam-boats going over at low water. It is the invariable practice, when we want to clear away a shoal, to go on the lower part of it, and work up, because any loose sediment is carried away by the ebb tide, and if there is any deposit the Trinity House lighters generally take it up. I am now at work on the Whiting shoal, which is in Limehouse Reach.

2422. Having removed that bank which formed at old London Bridge, you consider there are no further obstacles until you get to Limehouse Reach; where then do you consider is the next great obstruction below Limehouse Reach?—The next considerable shoal is what is called Ham Shelf, at Woolwich; that is a nuisance, particularly to Her Majesty's ships and vessels bound up into the docks and pools, that come up to Woolwich. Government has laid out a great deal of money in clearing that Reach, but, I believe, with very little effect, from the set of the tide. There is a point called Hookness which sets the tide over to Woolwich Dockyard, and in the slack tide the mud deposits and forms a bank. As fast as they take it away it forms again. Mr. Walker, in his Report of 1842, recommends with respect to the shoal, to cut off Hookness in order to direct the tide down in the centre of the river.

2423. (Mr. *Hume.*) A letter was addressed by you on the 11th of January, 1842, to the Thames Navigation and Port of London Committee, in which you state that you perfectly agree with Mr. James Walker as to the recommendations he offers to the Committee?—I do.

2424. What are the principal recommendations given by Mr. Walker in that Report?—Mr. Walker's plan was to lay down a straight embankment throughout the river without any projection, in order that the tide should have more effect upon the shore in preserving the depth of water.

2425. Does he not recommend that any projecting points should be cut off, and any hollows filled, in order to give one uniform channel sloping from each side to be the deepest in the centre?—Yes; I perfectly agree with him upon that point.

2426. Did you examine the map which he gives of the width at different parts which he proposes to maintain?—I did.

2427. Captain Bullock appears to have concurred also in that Report?—Yes; I attended that survey, and approved of the lines which I considered to be the best from my practical knowledge of the river.

2428. Mr. Walker says in one part of the Report that it would be discreditable that the irregularities in the present bottom of the river above London Bridge should be suffered to remain when the immense importance of the navigation is considered. Could the irregularities you first spoke of be in some degree removed?—I am aware of irregularities above bridge; but my duties are strictly confined to below bridge.

2429. You recommended to the Navigation Committee that they should deepen the river from London Bridge downwards in that regular form, making the depth part of the current in the centre of the river throughout?—I did.

2430. Why have you not carried that out, and begun your excavations agreeably to that plan?—I am not aware: it is under the direction of the Navigation Committee. I have occasionally pointed out those difficulties, and, in fact, recommended them to be removed.

2431. In that Report it is stated,—"Above London Bridge, gravel and sand for repairing roads, making foundations, and other purposes, are raised by permission of the Lord Mayor, as Conservator of the Thames; and individuals thus authorised take such materials wherever the quality suits them, without sufficient regard to the navigation." To what is allusion prin-

Capt. John Fisher, R.N.

July 2, 1845.

cipally made?—Mr. Walker, when he made that report, considered it ought to be under proper authorities to point out the situation where those people were to work in the Channel. They had been in the habit of working at different places, making holes; and in some places there would be 5 or 6 feet of water, and at other places not one foot.

2432. What places do you allude to?—I mean above London Bridge.

2433. Under what authority were they allowed so to do?—By the Lord Mayor, under the direction of the water bailiff.

2434. Does the Lord Mayor give permission to parties to take sand and gravel where they please, without directing them to take it from the shallowest part of the river?—It was so formerly, but is not so at present. It is under the direction of the water bailiff.

2435. Has any alteration been made in that respect since 1842, when that Report was made?—There is considerably more water in certain places, but they have not carried it up through the Channel.

2436. Are those who are allowed to dig below under any rule or regulation as to the place from which they are to take it, so as to make it uniform?—It is under the direction of the water bailiff to direct them where to work.

2437. Does the water bailiff carry that out?—I am below bridge; but I believe he is very particular.

2438. (*Capt. Beaufort.*) Is the water bailiff a man who understands what ought to be done, and what ought not to be done?—He understands it perfectly.

2439. (Mr. *Hume.*) It is stated in this report,—"A main object is to take means for removing those encroachments by an approximation to a uniform width and depth." Have means been taken to have an uniform width and depth by all the excavations that have been made?—No.

2440. Why have they not?—That is a question I cannot answer.

2441. Do you see any difficulty in that being done, if the plan pointed out here was carried out under proper authority?—I think not, but it would be done at a considerable expense.

2442. Is it your opinion that the river might be widened from any part upwards, by adopting the course which is stated in this report of Mr. Walker?—I think not: I think there is no necessity for giving it greater width below London Bridge; there is quite sufficient width for the passage below the bridge.

2443. My question is, whether you see any difficulty in the widening being made regular from each side to be the deepest in the centre, as pointed out by Mr. Walker?—There is no difficulty in doing it; but it would certainly affect a great many interests in water-side premises.

2444. Does not Mr. Walker recommend that all those on each side should be called on to pile and defend their premises, so that you might secure the depth in the centre of the stream?—Yes.

2445. If that was done, would not it very much improve the harbour and ship-way?—No doubt of it. It may be necessary to observe, that they have got a plan of running out jetties, barges, and craft, from different landing places; most of them are in private hands; and two-thirds of the time those barges are grounded. The consequence is, that it stops the free current of the water, both on the ebb and the flood, and there is an accumulation on the shore; not in the middle of the river, but on the banks.

2446. Does not the Navigation Committee recommend the removal of all these nuisances, and object to the manner in which license has been irregularly given?—Yes.

2447. Have any steps been taken since that Report pointed out the absolute necessity of removing those jetties, to prevent the accumulations which have taken place there?—No; some have been removed, but the most objectionable still remain.

2448. Where?—There is one at Greenwich, which runs out from the Garden Stairs. The parties have taken possession of the public stairs; they prevent the watermen coming in, and obstruct them in their passage, besides stopping the circulation of the free current of the tide.

2449. Do you concur in Mr. Walker's opinion, that every jetty interfering with the channel of the water tends to injure the harbour by interrupting the current, and introducing eddies?—It does.

2450. Ought not every one of those jetties to be removed if you wish to improve the river effectually?—Yes; but for the benefit of the public, I think there might be some jetties at different points put out under a proper authority, and not in the hands of private parties, if those jetties were erected on proper principles on open piles.

2451. If jetties sufficient for public accommodation upon open piles were raised, would not that prevent the accumulation which is now going on at those several boat jetties?—Yes.

2452. Has any representation been made by you, or any of the harbour-masters, since this Report in 1842, in which you entirely concur?—No; I have repeatedly, in conversation with them, when erecting jetties, recommended them to pile it down. At Greenwich, the pier that I have complained of was constructed; I removed it three times, considering it was a nuisance. The Lord Mayor (Alderman Humphrey) sent me an order, which I am bound to obey, to let it remain, and there has been a constant state of warfare respecting it.

2453. You find that the change of Lord Mayors, and the applications of different parties, produces uncertainty as to orders, and renders it difficult to act on any one system?—No doubt of it. I conceive that if there was a Commission of Nautical Men to be constantly at work, elder brethren of the Trinity House or Lords of the Admiralty, those views would be carried out, and the river would be considerably improved by having people who understood it.

2454. Do you mean to say that if there was one authority for carrying out the plans recommended by Mr. Walker, Captain Bullock, and yourself, the whole of the river, from London

Bridge down to Woolwich, might be cleared in the way pointed out in this Report?—Yes; and much more expeditiously.

2455. Can you state why the Whiting and other shoals have been allowed to remain so long to interfere with the navigation?—I am not aware; I found the Whiting Shoal there, but since the docks have been made, a larger class of ships come up the river. Formerly there were no impediments, but now it is necessary there should be depth of water to give them accommodation.

2456. Do you recollect the state in which the navigation was before the old London Bridge was taken down?—Yes.

2457. What has been the effect with regard to the scour of the water since the new bridge was built?—In the lower part off London Bridge below, I find very little difference at all. The old London Bridge acted as a dam; it has prevented the body of water from going up. We have had, certainly, rather higher and lower tides than we used to have formerly. In spring tides it is occasionally three feet above the Trinity standard higher than it used to be.

2458. Do you mean that the tide has risen higher than it was before?—I do not say generally; we have had that before.

2459. It is stated in this Report, that the increase of the scour since the removal of London Bridge, as well as the action of the paddle wheels of the steamers, have tended much to deepen the channel from London Bridge downwards?—It has.

2460. Then the river is deeper?—It is deeper in the channel.

2461. What would be the expense of commencing at London Bridge, to carry out Mr. Walker's plan regularly from each side to the centre, and making the river like a canal, as he reports?—I cannot exactly agree with Mr. Walker upon that point. By making a depth of water for steam boats, it will injure the large wharfs on each side; it will take away the support of the foundation by carrying it to such a length as that.

2462. Does not Mr. Walker recommend that pilings should be placed along by the whole of the banks on each side, so that the property should be so protected?—Yes.

2463. If that were done, could not the navigation be improved?—Yes; it would assist the foundation walls, and prevent their tumbling, but I think there would be great difficulty in getting parties to go to such an expense. It is practicable.

2464. Are you allowed to sell the gravel which you raise?—We can dispose of it for concrete for railroads, or any other purpose; we are not allowed to ballast ships from the excavations.

2465. Do you raise any mud?—There is hardly any mud to be found now; the steam-boats wash it all away.

2466. If you were allowed to sell the shingle for ballast to whoever would take it, would that pay the expense of the dredging?—No, but it would assist in paying it.

2467. To what extent would it assist?—I cannot say; it depends upon the quantity; but, taking an average, perhaps one-fourth.

2468. (*Capt. Beaufort.*) How much will a vessel raise in a-day?—On the Whiting Shoal we have been raising 100 tons per day.

2469. (Mr. *Hume.*) Have you had occasion to blow it up, or has it been by ordinary dredging?—All this hard rocky stuff, when the engine gets obstructed from lifting it, I blow up by gunpowder.

2470. What kind of materials have you brought up?—There is a sample of it here; it resembles plum-pudding stone, or a conglomerate of gravel, oyster and other shells, apparently being a calcareous cement. This has been in a loose state; it is probably the action of a mineral spring, which has come up through the water, that hardens it.

2471. Has that not been the most difficult shoal of the river to remove?—Yes.

2472. In other parts of the river where there is shingle and earth, what quantity could you raise per day with one vessel?—The Trinity House with their steam-engine has raised 120 tons in 35 minutes.

2473. Have you not employed steam dredging-boats yourself?—I have one now.

2474. How many horse power is that dredging-boat?—About 20.

2475. Have you employed that machine in any other place but the Whiting Shoal?—No.

2476. Are you able, from what you have seen, to state what quantity a dredging-machine of 20-horse power would bring up of shingle in the course of a day?—The Trinity House could give more correct returns than I am able to do.

2477. Suppose these two engines were placed at your disposal to be continuously employed to clear out the river, as recommended by Mr. Walker, do you see any difficulty in that being done?—It could be done no doubt in the course of time.

2478. Supposing two lighters were placed under your charge of the same power as the Trinity lighters, do you consider that you could carry out the recommendations of Mr. Walker and others respecting the river from London Bridge downwards?—I cannot positively say that it could be done, but I think it might.

2479. If these lighters had been employed during these last 20 years in that work, do you not consider that the river might have been cleared down to Woolwich by this time?—I do not think it possible, taking the rock and all together.

2480. Is there rock in any other part of the river that you know?—At different parts of the river there is concrete formed in-shore, and there is a good deal below Blackwall. When we get to the gravel, after getting down a certain depth, we get into a harder material; but the greatest difficulty is the clay. There is a substance of clay under the gravel which hardly any engine will penetrate; when a powerful engine belonging to the Trinity House has been at work, I have seen the end of the iron buckets rolled up.

2481. Do you see any objection, but that of expense, to clearing the river agreeable to the

Capt. John Fisher, R.N.

July 2, 1845.

plan in which you concur with Mr. Walker?—None at all; the expense is the only objection.

2482. Are you able to give any idea of what the expense would be in employing two dredging machines per day and selling the material you take up?—I am not at all prepared to state that.

2483. With respect to the dredging-machines of the Trinity House at work in those parts under your charge, what rule is laid down respecting their operations?—Wherever there are any banks the Trinity give directions for their ruler to work upon them, and to work the part which is fit for ballast.

2484. Who removes such parts as clay which are not fit for ballast?—I cannot state; the Trinity House do not.

2485. Are we to understand that the Trinity House do not take up mud which lies in the middle of the river?—Certainly not.

2486. Does not mud impede the navigation as well as shingle?—At present we have got no mud.

2487. (*Capt. Beaufort.*) You have peat and clay instead of mud?—The principal part we have to contend with is loose gravel, which forms a sort of concrete.

2488. (Mr. *Hume.*) Have you not just stated there is a mud point opposite Woolwich?—It is the point which projects from Woolwich; it is not mud, but hard gravel.

2489. According to your statement, there is no impediment now to clearing the river of a uniform depth from London Bridge down to Woolwich, except the want of means?—I am confident, with the machinery we have now got, and the means of exploding by gunpowder, there is no difficulty except the want of funds to carry it on.

2490. You are not able to state what that would amount to?—I am not.

2491. Could you sell more gravel, if you had it, for concrete and other purposes?—I am not aware that we could; it depends on the work that is going on. The principal concrete that we get up that has been sold for a railway is raised above bridge—from Westminster Bridge down to London Bridge.

2492. There is no difficulty, then, if a proper plan were followed, in having a regular channel deep in the centre from Westminster Bridge down to London Bridge?—None.

2493. But there being no system followed, it is irregular, as you now state?—The parties at work for the concrete go and dig up the stuff which suits their purpose; they will not keep to going through the channel; they take the stuff that is got up the easiest.

2494. Does not that injure the navigation instead of tending to make a uniform channel?—Yes.

2495. Is it not contrary to what Mr. Walker recommends, as to the deepening and equalizing the bed of the river throughout?—Certainly.

2496. Then all these orders are against the opinion of Mr. Walker, and that which you yourself have given?—This is done above bridge; I direct them below. My object is to keep a good channel for the ships in a fair way; but above bridge the water-bailiff, I know, has ordered them to clear the channel from the middle arch of one bridge down to the other; and, as far as I know, I rather think he attends to the working of those steamers.

2497. (*Chairman.*) Have you any authority from the water-bailiff?—No. The water-bailiff is called a sub-conservator of the river Thames: he is appointed by an old City of London charter; I am appointed by Act of Parliament.

2498. (Mr. *Hume.*) In this Report, with which you concur, it is stated, "By a grant or charter from Charles the Second the Trinity House Corporation were authorized to receive certain fines and contributions, to be applied in removing shelves and annoyances in the river; but these fines having long since been other ways appropriated, and the Trinity being therefore left without funds available for these purposes, the grant has, I believe, been in this respect a blank letter;" do you know to what that refers?—I do not.

2499. (Mr. *A. Chapman.*) Are you aware that, whenever any shoal comes under your notice raising a difficulty to navigation, it is customary to apply to the Trinity House for them to set their ballast-lighters to work to take ballast from that shoal?—Yes; I have made application to the Trinity House when those shelves have got up, and I have found no difficulty whatever unless it does not answer for ballast.

2500. So long as it answered for the purpose of supplying ships with ballast, and the ships were willing to take it, did those lighters continue to take the impediment away from the river?—When I have represented it to the Trinity House, the Trinity House have immediately set their lighters to work upon it; but if they found the material on the shoals not fit for ballast they have discontinued it.

2501. (*Capt. Beaufort.*) Is it not all fit for ballast if there is no mud?—There is very little but what is fit for ballast now; but there are some parts so hard that it would not pay the men (who get so much per day) for getting it up.

2502. (*Chairman.*) In point of fact, are there now any such banks or obstructions in the river which are not removed because the Trinity House lighters do not work upon them?—They have tried to work upon the Whiting Shoal, and in consequence of the damage their machine received they left off. No machine could work upon that unless it was removed by gunpowder. I am going to apply for one of the Trinity House engines to follow this up, and I have very little doubt I shall have the assistance I require from the Trinity House. We frequently have some of the Trinity House lighters at work, taking up the Whiting Shoal, besides our steam-engine; they take up on an average about 100 tons daily.

2503. (Mr. *Hume.*) Will the Trinity House Lighters take any material from the bed of the river unless the material can be sold for ballast?—Certainly not.

2504. This Report of 1842 states that there were "several wrecked vessels sunk in the navigable channel of the river;" have they been removed?—I have blown three or four of them up myself.

2505. Are they all removed now?—No; we have got four or five more within the last twelvemonth.

2506. Whereabouts are they sunk?—From Northfleet Hope down to Sea Reach.

2507. Are they in deep water?—One vessel I raised last year, the Atlas. She sunk in 10 fathom water. In consequence of the obstruction to the tide in Higham Bight, there was an embankment of sand formed round her of about 50 feet; and I am confident if that vessel had been allowed to remain there, the bank would have extended further over on the Essex shore, and in the course of time would have been an obstruction.

2508. Why were not a couple of engines put to remove the sand?—I moved the vessel up, and since that the sand has all dispersed.

2509. The wreck was the means of collecting the sand?—Yes.

2510. What prevents you removing any other wrecked vessel that remains now?—Nothing at all. The City of London are now entering into a contract for removing the remainder that are sunk.

2511. Where are these vessels wrecked?—There are two barges in Northfleet Hope, one in Higham Bight, one off Hope Point, and two vessels in Sea Reach, which are laden with Macadamized stone.

2512. (*Capt. Washington.*) Are they not on the edge of the Bligh Sand, near the same spot that the French steamer-of-war, carrying back the Duc de Nemours, grounded in 1843?—Yes.

2513. What do you think was the probable cause of those vessels being wrecked?—I believe by collision with colliers.

2514. (*Chairman.*) Whenever vessels are sunk, are immediate measures taken by the corporation or any other authority to remove them?—We generally send to the under-writers and owners to remove them; and if they do not, after a certain time, the corporation of London take them in hand themselves.

2515. What do you call a certain time?—The last one I raised had been there 18 months.

2516. There are no immediate measures?—No; it depends on the situation where the vessel is sunk: if it is sunk in the centre of the river, where the navigation of the river is obstructed, immediate measures are taken to raise it, otherwise they are in no hurry about it.

2517. Who is the proper authority to give orders for weighing vessels that are sunk?—The Lord Mayor, as the conservator of the River Thames.

2518. (Mr. *Hume.*) Are orders given immediately to remove a vessel that is sunk?—No; it depends on the situation the vessel is in. If it forms a material obstruction, measures are immediately taken for its removal.

2519. What is the longest time you have allowed a wreck to remain sunk?—The Grampus lay 20 years; but that was wrecked long before my time.

2520. Where did she sink?—She was wrecked on Barking Shelf.

2521. (*Chairman.*) Does that Shelf exist now?—Yes; although it has been considerably reduced by the Trinity lighters working on it for ballast.

2522. (*Capt. Washington.*) Did not that very shoal stop the Royal Yacht, with Her Majesty on board on her return from Scotland, from coming up to Woolwich, for two hours last year?—Probably; but I was not aware of it.

2523. (Mr. *Hume.*) You say that a considerable portion of the Barking Shelf has been removed. What is it that remains; is it clay and peat, which existed in 1842?—It is composed of silt and gravel.

2524. Why is not that removed?—I am not aware.

2525. Could it be removed?—It could be removed, but at a great expense; it has, however, been gradually reduced by the Trinity House.

2526. But the Trinity House only take gravel, you state?—That stuff answers very well. I have seen 30 or 40 of those dredging vessels lying there in the course of a tide.

2527. It is stated that in Cold Harbour a point of sand extending from the north shore to the middle of the river, eight feet deep, existed in 1842; does that exist now?—Yes.

2528. Why has not that been removed?—I am not aware, but I think the reason is because there is sufficient channel on the east side of it towards the Kentish shore.

2529. Would not the removal of that make the channel better?—It would make it wider; but we consider we have sufficient width without that.

2530. It is said there is a shoal of sand in Erith Reach, 200 yards above Cold Harbour Shoal, with a depth of six feet; does that still remain?—Yes.

2531. Why is not that removed?—I do not know; but I believe for the same reason that I mentioned before, that there is a sufficient depth of water on each side of it.

2532. Do you know where Dagenham Shelf is?—Yes.

2533. It is stated in this Report that that extends from the north shore, nearly half way across the river, with eight feet water. Does that continue?—I do not recollect any shoal of that kind. I think it is pretty well gone away, because there is sufficient depth of water for vessels to go of any draught down to there.

2534. Do you know at Bugsby's Hole there is "a shoal water reach in places only eight to nine feet, with some shelves and small shoals, having only six to seven feet;" does that remain?—There is a shoal there which runs from the Essex shore right down; but on the Kent shore the channel lies. I put 75 sail of colliers in that section, and since the colliers have lain there it has increased the depth of water, I may say, four or five feet.

Capt. John Fisher, R.N.

July 2, 1845.

2535. Did not Mr. Walker contemplate the removal of that so as to give a uniform channel?—Mr. Walker's plan was to make a uniform channel throughout. There is no doubt all those shoals, if they could be removed, would be very beneficial.

2536. It is stated that opposite the River Lea the shore gained from the north side only eight feet; does that still continue?—There is quite sufficient water coming round Blackwall Point. Some part of it is hard material.

2537. In the middle of the river?—It does not extend; in the middle of the river there is quite sufficient water.

2538. In 1842 it is stated that the middle grounds in the centre of the river, between Blackwall and Greenwich, had upon them nine to ten feet; have these been taken away?—The middle grounds stand at present like a sugar loaf; there is no breadth to it. The Trinity House lighters have been working upon it, and they have made 14 or 15 feet all round that; the top of it is deepening. The shoal has been reduced.

2539. Have they been dredging all round it?—Yes.

2540. Could not that be blown up, as you have done Whiting Reach?—Yes; but it is a loose kind of material.

2541. If it is loose, why did not the dredging machines take it from the middle of the river?—I am not aware; it is gradually reducing. There is a sufficient channel upon the east side of that, or upon the west side, for ships to pass. I have never seen a vessel grounded on it for years.

2542. (*Chairman.*) What is the nature of the shoal you are speaking of?—It is hard gravel and pebbles.

2543. (*Capt. Beaufort.*) Petrified?—No it is not petrified, but it is very hard.

2544. (Mr. *Hume.*) You are aware that this plan of Mr. Walker's recommends that embankments should be made in low places, and that the materials should be taken out of the river to fill up the edges of those embankments, keeping the width pointed out in his plan; have any of these embankments whatever been made?—Several.

2545. Whereabouts?—In the upper Pool there are several brought out, according to the line of Mr. Walker.

2546. Have the materials from the bed of the river been put in there to fill up behind?—They have not. They have got permission from the Navigation Committee to carry out this line according to Mr. Walker's plan, and they filled it up in any way they could.

2547. Would not that be an easy mode of disposing of clay and stuff that is not fit for ballast?—There is very little doubt that it would, but we do not interfere with that. I believe a good deal of material that comes out of the river is thrown upon that part.

2548. It is stated as an objection the throwing in ashes and materials from the city; have any orders been given to prevent ashes being thrown in?—Every one that is found throwing them in is liable to a penalty; I have seen very little of it; it might be done in the lowest part, but in the upper part the ashes are too valuable to throw away. From Westminster upwards, I do not believe there is an atom thrown into the river.

2549. Are the Board to understand from all your experience, that there would be no difficulty in making the river Thames a deep channel of uniform depth from London Bridge downwards, provided the expense necessary for that purpose was provided?—I think no difficulty; with the machinery we have now got we can do anything.

2550. Do we understand that the Lord Mayor is not allowed to take up any gravel and sell it, below the bed of the river, to any vessel?—Not for ballast.

2551. If they were allowed to sell the ballast, would they continue the work of dredging?—They would continue the work of dredging; but I cannot say how they would dispose of it. With the aid of gunpowder, &c., and the galvanic battery, it is proved that anything can be knocked away. With 45 lbs. of gunpowder I have tried under a shoal, and I have tried it on the top; and laying it on the top, it is generally all broken up to 30 or 40 feet in diameter.

2552. (*Capt. Washington.*) You have referred to the Trinity standard; will you state who placed those standards, and where they are placed?—The Trinity House placed them; every dock has got the mark of the Trinity standard; from Greenwich up to London Bridge we have stones to put down; and at several points.

2553. Do you state that you placed them?—The Trinity House placed the marks upon the Bridges, but on the shores I have placed them and stones in the river with the Trinity standard marked upon them.

2554. Are these standards all placed at the same level?—They are.

2555. By whom?—By Mr. Elmes, Surveyor of the Port of London.

2556. Are they kept clean so as to be always visible, and referable to in case of need?—They are.

2557. Have you seen these marks yourself at different bridges?—I have; several of them have been out from the washing of the steamers, and we have taken the levels again and replaced them upon the proper level.

2558. Is not the level cut or let into the stone?—There are marks on the bridges. We take the level of the stones, and these stones are let into the ground.

2559. Will you describe the nature of the standard; is it a metal level let into the stone, or is it scored in the face of the stone, or painted?—It is granite stone cut out with a chisel.

2560. (*Capt. Beaufort.*) You said, alluding to Woolwich, that the mud still accumulates in front of the dock-yard?—It does.

2561. Can you suggest any means of keeping the front of the dock-yard clear?—There is very little doubt if it was taken away it would be all the better, but Mr. Walker says in his report, that unless the point on the Essex shore is cut off, as fast as you take it away it will accumulate again. It has been worked constantly; I believe it has cost Government 1000*l.* at different times, or more; and in two or three years it has got as bad as it was before.

Capt. John Fisher, R.N.

July 2, 1845.

2562. How much of that point would be cut off?—It is marked in the plan.

2563. You agree with Mr. Walker?—Perfectly; it will make a more uniform set of the tide.

2564. With respect to the shingle for ballast; when there is more raised than can be disposed of, is there any flat, covered at high water, on which you can deposit it?—It may be deposited for different purposes; we deposit a great deal of mud out of the Docks; we throw it down on the embankment at the Isle of Dogs and other places to keep up the embankment.

2565. And there is sufficient space to lay out any quantity of shingle that might be raised out of the shoals?—Yes. Mr. Cubitt is going to carry an extension of the wharf from Greenwich Ferry; he has taken a great deal of the deposit of the river from that place to fill up.

2566. (*Chairman.*) Will you state to the Commission what general improvements you would recommend in the river?—I recommend Mr. Walker's plan of a regular line of embankment and removal of the shoals. As far as regards the moorings, they are perfectly complete; the colliers were formerly moored at their own anchors, and constantly breaking adrift. I have laid down stones of 11 and 12 tons, and embedded them 12 feet, and they keep their station in the channel, and a wide water way of 300 feet through the Thames is preserved. There is another improvement I should point out. Formerly I had no power below Blackwall; I have got the power now; and instead of having that glut of colliers in the upper part, I have got sections between London and Gravesend. When they come to Gravesend they are ordered to the different stations, and as vacancies occur orders are sent down from London for a number of colliers to fill up those vacancies. I think last January I had 900 sail of colliers between Gravesend and London Bridge.

2567. Do you find in practice any difficulty or delay arise from part of the duty of carrying away the shoals of the river devolving on you and part on the Trinity House?—Yes; at Woolwich Reach they are obliged to wait till there is sufficient water to go over Ham Shelf. I have known steamers wait an hour and a half, or two hours, to go over that.

2568. What do you consider a sufficient depth?—14 feet.

2569. You mean it is unnecessary expense to work below 15 feet?—Yes; below that Reach and above it we have 16 to 20 feet water; off the lower part of Deptford upwards of 20 feet.

2570. (Mr. *Hume.*) You have stated that Government have been at considerable expense about Woolwich; do you continue of opinion that if Hookness was rounded off, as stated by Mr. Walker, that mud bank would be much lessened, and perhaps swept away?—There is not the least doubt of it.

2571. Would not the cutting of that be less expense than the Government are at yearly in attempting to keep Woolwich clear?—There is no doubt of that. They may go to what expense they like, and they would not keep Woolwich clear, except that point was cut off. Government have been at considerable expense, and for years they have had the work going on, and as fast as they take it it gets bad again.

2572. (*Capt. Beaufort.*) You were speaking of the pier that is run out at Greenwich. There was a straight wharf of stone just above the Hospital which tumbled in; might not that have been kept sufficiently clear for the use of steamers by a judicious dredging in front of it?—That, in my opinion, would have been quite sufficient space for steamers, if it had not fallen in.

2573. Could it have been kept clear at low water by dredging alongside of it?—It could be done; but I think it would affect the foundations of the wharf.

2574. By judicious dredging on the hollow side of the river, can deep water be kept sufficient for all those steamers that go up and down the river?—I think not; I think it would fill up almost as fast as you take it down; and, again, where you have got a long pier like that, there is a rise and fall of tide of 18 feet. By having a barge outside of the pier, from the rise and fall of water the barge rises and falls with the tide, and, of course, it is more convenient and safe for the passengers to land from that, and the steamers to come alongside. I do not think any steam wharf or pier could do without something of that kind. At Billingsgate they have got a thing of this sort, and we do not find it any inconvenience, and fish-boats come alongside, and they have ladders at low water from that to the market.

2575. Is there any deep water alongside that iron wharf at Blackwall?—They have got barges there; but that is no obstruction whatever to the river.

2576. Why cannot wharfs be kept sufficiently deep for those steamers to go alongside?—There is no doubt of it, if they have depth of water.

2577. If the water can be kept sufficiently clear and deep on the concave side of the river at Blackwall, why cannot it be sufficiently deep and clear at Greenwich?—By going to expense it could be done. There would be no difficulty in it; but it would be attended with great danger, unless they had a barge alongside for the safety of the passengers landing. I may mention with regard to those piers running out, I agree with Mr. Walker, as to having a regular and uniform frontage for the river.

2578. You still suggest the propriety of having piers or open piles sticking out in the river?—I say where the public require it, and for their accommodation it ought to be done on piles, but on no other principle, because the piles will allow a free circulation of the current ebb and flow, and prevent accumulation.

2579. If the water is sufficiently deep, and the wharfs sufficiently long for the steamers to go alongside of them fore and aft, what objection is there as to the convenience of the public in that respect?—There would be no occasion to put any projection out if that was the case.

[*The Witness withdrew.*]

Mr. *W. Cubitt*, C.E.

July 2, 1845.

Mr. *William Cubitt*, C.E., examined.

2580. (*Chairman.*) You are a Vice-President of the Institution of Civil Engineers?—Yes.

2581. How many years have you been an engineer?—Upwards of 40 years.

2582. What tidal rivers and harbours have you examined and reported upon?—I have examined in a professional way, or reported upon the following; viz.—

Aberdeen Harbour,	Hayle Harbour,	Southwold Harbour,
Aberystwith Harbour,	Harburg Harbour,	Swansea Harbour,
Arbroath Harbour,	Hastings Harbour,	Shannon Navigation,
Ballyshannon Harbour,	Harwich Harbour,	Severn Navigation,
Bute Ship Canal,	Humber River,	Sunderland Harbour,
Ballyteig Lough,	Kingstown Harbour,	Southampton Docks,
Berwick Harbour,	Leith Harbour,	Tees Navigation,
Belfast Harbour,	Lowestoft Harbour,	Tyne River,
Birkenhead Docks,	Langstone Harbour,	Wisbeach River,
Clyde Navigation,	Loughs Swilly and Foyle,	Wyre Harbour,
Dover Harbour,	Mulloghmore Harbour,	Weymouth Harbour,
Dublin Harbour,	Mersey River,	Waterford Harbour,
Exeter Navigation,	Medway Navigation,	Wexford Harbour,
Folkstone Harbour,	Newhaven Harbour,	Welland Navigation,
Falmouth Harbour,	Newry Navigation,	Yarmouth Harbour,
Faversham Harbour,	Rye Harbour,	And some others.
Grangemouth Harbour		

2583. In the course of your experience, have you been enabled to lay down any principle which is generally applicable to the improvement of tidal rivers?—I know of no general rule applicable to tidal rivers. Every case must be considered under its own circumstances.

2584. What are the chief obstructions to the propagation of the tide which are generally found to exist?—Crookedness of channel, unevenness of depth, and varieties of composition of the bottom and sides.

2585. Explain in what way these obstructions operate?—By causing eddies, sand or mud banks and deposits, and in a continual tendency to increase the evils.

2586. How can such obstructions be most effectually removed?—By a variety of modes, according to the circumstances of the case, *videlicet*, groining, wharfing, embanking, dredging, scouring, &c. &c.

2587. Are you of opinion that depths in rivers and their powers of scouring are chiefly due to the volume of water brought down in the freshes, or to tidal waters?—Chiefly to the tides as far up as the neap tides reach, and above that point principally to the freshes.

2588. Is there more to fear for our river harbours from the detritus brought down by the stream, or to silt carried into them from the sea?—Generally speaking, to silt brought in from the sea.

2589. Can you state any instances in which works designed in conformity with the principles you have laid down, have been productive of beneficial effects?—In the Clyde, at Yarmouth, Newhaven, Faversham, the upper tideway of the Severn, and many other places.

2590. Have you acted in every case upon the same principle?—No.

2591. Can you state any instances in which works designed in conformity with the principle or principles you have laid down have been productive of beneficial effects?—Yes.

2592. (Mr. *Hume.*) You are satisfied that in all these harbours great benefit has resulted from the application of art to assist nature?—Yes; but there are some cases in which nature beats all our art.

2593. (Mr. *Godson.*) You are, I believe, the engineer for the Severn Improvement Navigation?—I am.

2594. Have you proceeded to carry the operations into effect in that river?—Yes; we improved the Severn on two different principles; first, in the tideway as a tidal river, we improved it by contracting where it is too wide by embankments, by fascines, and other substances, and by dredging it where it is too shallow; that is, making it as much as possible by art of a uniform width and a uniform depth to ensure a perfect navigation, and which is succeeding to the utmost extent of my expectations. The other portion of the Severn, after the tide ceases, is improved by making the river into different levels or ponds, and connecting them by means of locks and weirs, so as to take off all the flood waters over the weirs and pass all the navigation through the locks.

2595. How many weirs have you erected on the Severn?—Four.

2596. By means of those four weirs, how many miles of navigable river have you now been able to obtain?—We have obtained a constant and uniform depth of six feet of water and upwards for nearly 20 miles, where formerly in places there frequently was not above eighteen or twenty inches for many months, and the navigation entirely at a stop; and we are now obtaining the same improved depth of water for nearly 30 miles in the tideway above Gloucester, by making a uniform breadth and depth of channel by the means I have stated. That is now nearly completed.

2597. Taking the whole together, in consequence of the four locks out of the tideway, and by fascines in the tideway, what is the whole length of your improvements in the Severn?—Upwards of 40 miles.

2598. Is it your intention to put any more weirs in the Severn, or are those sufficient?—Those are all we shall put under the present Act.

2599. Have you heard of the attempt to cross the Severn at a place named Hock Crib?—I have.

2600. Would it or would it not be detrimental to that navigation to permit a bridge to be put over the river anywhere there?—If I were instructed to improve the navigation of the Severn for sea-going vessels, I should make a ship canal across the isthmus at Hock Crib and Framilode, for the purpose of obtaining a navigation, with double stop-locks at both ends of that cut. That would be a portion of the works I should propose for improving the Severn, leaving the river to go in its present channel round by Newnham; but combined with such cut and locks, I should embank off and reclaim many thousand acres of land on the Nooze sands, just below, in order to make a proper channel below for vessels to come up the same cut. That would both gain land and improve the navigation, and also improve the river above; but a cut across the isthmus, and with locks in it, must, I think, whatever be done, form a portion of the works for the improvement of the Severn navigation.

2601. Would that be quite independent of bridges?—So far that would have nothing to do with bridges, except the bridges of the roads which cross into the island; but, as an engineer, I should explain that I offered no objection to their making the cut, provided they made proper works, and kept them up at their own cost. It does not necessarily follow that the tide should be allowed to flow up to Gloucester, in order to improve the Severn, even in the best manner, because there are two or three modes by which the Severn might be very materially improved. One is by letting the tide go up, and another is by not letting it go up. If we were to stop the tide altogether at Hock Crib, it might be made a better job for all the lands above and for all the lands below, and for all the navigation, probably, without doing anything to control the tide.

2602. (Mr. *Hume.*) What difficulties do you allude to in controlling with regard to the flood tide?—If we were to do the best we could to make a channel all the way up to Gloucester, the tide comes so strong from the trumpet mouth of the estuary of the Severn, that it carries a bore all the way to Gloucester, and that is productive of great evil both with regard to navigation, and with regard to the banks of the land; and it is a very difficult thing indeed to control; whereas we could bring a river with 10 or 20 feet of water all the way down to Hock Crib, if we stopped the tide at Hock Crib, and pass all the land water by a weir, and never have the river silt up at all.

2603. Does not a tide so strong as that which comes up with the bore tend to keep and deepen the channel if kept within limits as to width?—It is difficult to keep it within limits. These things are all good or bad, according to their cost. If from Hock Crib we could be sure of 15 or 20 feet of water at all times to Gloucester, and all was quiet, it would be a fine thing, much better than having a roaring furious bore all the way.

2604. You think that benefit might arise from having, as it were, an inland navigation from Hock Crib, by keeping the tide beyond it?—I could take the whole of the land flood-water off over the weir not more than two or three inches thick during the heaviest floods that ever came down that part of the river into that navigation, and by steaming, or sailing, or tracking, there would be a perfect navigation for 60 or 70 miles up to Stourport.

2605. You have mentioned Rye Harbour; will you state on what principles the navigation of the harbour of Rye could be improved?—The only way to improve the navigation of the harbour of Rye is, in the first place, to get a good channel out from Rye to the low-water channel of the sea, which is about a mile and a-half from the present pier through sand. They are now acting gradually upon a recommendation of mine, in carrying out a breakwater straight across those sands, which, as far as it has gone, acts admirably well.

2606. Is it your object in erecting that pier to prevent the ebb tide from spreading over the sands on both sides?—It is to keep it to one place.

2607. Have you attended to the flow of the river above Rye?—A great deal.

2608. Have you visited Scot's Float Sluice?—Yes, many times. That has been lately rebuilt under my particular notice.

2609. What would be the effect of removing that sluice so as to allow a flow of tide upwards?—I must revert to what it was formerly, and how it came to be as it is now built. Many years ago the River Rother went up beyond Rye, up to the channel of the valley of Rother, a considerable distance, 15 miles at least. It was a very flat, sluggish, sort of river. It began to silt up a good deal, and the water came sluggishly to it, until at last a portion of the river was what was, at that day, termed inned out, they made a bank across the valley, and at the end they stopped the tide, and the lower land that began to be dry they reclaimed and stopped it, and that left those lands in *statu quo;* they did not rise any more after that. Subsequently the land outside the bank began to rise, as it always will where the tide is stopped, until other land in the valley became lifted higher than the first land, and they were inned out, and, I think, a third set were inned out until at last they came to Scot's Float Sluice, and there they made banks and carried the water off through the sluice as it now goes; and the effect is that the lands which were last drained and inned out are several feet higher than the land which was first inned out, and when they began those lands were many feet lower. Wherever we embank against the sea, in almost every case outside next the sea, the embankment of land rises very fast, but it never rises any more inside. If we take the case of the Nene at Sutton Bridge, that was effected at great cost, and they saved several thousand acres of land. Since that was done the land has risen six feet, and they are now taking 2000 acres more in from the open sea. Before taking down Scot's Float Sluice the banks of the river must be raised and strengthened to a great degree.

2610. (*Capt. Washington.*) To what degree, three feet?—More than that. As I have stated, the ground they last reclaimed is many feet higher than that which was first reclaimed.

2611. (Mr. *Hume.*) Then the volume of water that would flow up is so great that they would have to bank up?—It is, because what they first took in was so much and so high up the country.

Mr. *W. Cubitt*, C.E. July 2, 1845.

You would have to embank those lands out not only to high-water mark, but to meet floods on the high water again.

2612. You have attended to the progress of that?—Yes. If you embank out and take down the sluice then an effect will come of this kind—that the sea will then in that narrow and confined channel deposit the silt so fast that it would choke itself up in a few years. At Tillingham Channel, a little while ago, to my knowledge, the gates were damaged, and it was left open to the tide, and became silted up, as this would be in the course of three or four years, and they could do nothing with it; and that would be the case up the Rother now by taking down the sluice and contracting the channel.

2613. Would not a larger quantity of water flow up, and would not the scour by the ebb tend to keep it clean?—No, because there is not enough; you have no volume, no surface, no carriage of back-water behind; it is a little stream.

2614. Are you aware of what took place in 1812, when the sluice was broken down?—Yes; I am generally aware that there was a question raised that if they left it down it would be a good thing; because, for a short time, great effects ensued in the locality of the sluice in scouring away a great quantity of mud, but that very soon ceased, and the thing would have been as it is at Tillingham Channel.

2615. Are you aware what alterations took place in the depth of the water opposite Rye, and at the place where you have lately erected the pier?—I do not think the bar was lower than it is now.

2616. We have evidence stating it was 3 feet deeper than it was before?—I doubt it.

2617. The harbour-master, who measured it, states that that was the fact; and that vessels drawing a certain depth of water came up then which could not come up now, and did not come up before; therefore, how can that be reconciled with what you have now stated?—Those things must be taken with a great deal of reservation, I think. There never was, within the memory of man, a greater depth of water up to Rye from the ocean than there is now, I think.

2618. (*Capt. Washington.*) If you were to dredge the river Rother up two or three miles, would not that make sufficient channel for the flood-water to pour off?—The flood-water gets off now, and you would not have more flood-water than you have now. The tide-water would run in and out; but there is not channel enough in the whole to hold sufficient tide-water to do any good compared with the expense of obtaining it.

2619. Can you point out any mode, by making a reservoir or any other means, of improving Rye Harbour?—If they pursue the advice I have given they would have a much better and a very good harbour at Rye; there is a scour from above. Nature has already filled up the whole valley, not only to neap-tide mark but above it.

2620. (Mr. *Hume.*) Are you aware that, in 1812, when the sluice was broken down, that the water flowed up 15 miles?—Yes; so it would to-morrow.

2621. Would not the scour of that have an effect tending to keep the channel opposite Rye clear?—Very little indeed, and that for a very short time; there is hardly anything of it.

2622. Are you not aware that, by the proceedings in the Clyde, to which you have alluded, great benefit has arisen from dredging, removing from the bottom, and straightening the channel?—Yes, to some extent; and if you were to pursue the same thing at Rye which I have recommended, the same effects would, in a great measure, be obtained; but they have got no more back-water, and have no reservoirs for the tide.

2623. And yet, by dredging, widening, and narrowing, so as to make a uniform flow to increase the current, the channel has been deepened?—Yes; they have not increased the current much. I dare say the current was greater formerly than it is now, but they have deepened the channel.

2624. (*Capt. Washington.*) And thereby made a reservoir?—It is quite a different case. Comparing one thing with another, the channel at Glasgow is made between the low-water mark and high-water mark; that is, between Greenock and Glasgow.

2625. (Mr. *Hume.*) Do you mean to say, as your deliberate opinion, that the more you open the river Rother to the flow of the tide the more the harbour will silt up?—No; I mean to say that if you could make the whole valley into a large reservoir, and remove some 15 or 20 feet of silt for perhaps half a mile wide and 15 miles long, nearly as it is said to have been in days of yore, then Rye Harbour will be scoured out in grand style. If things were so at this moment, or approximating to it at all, that would in time fill up with mud again, and it would cost more to keep it out than keeping it out would be worth.

2626. Do you mean to say that, by the great quantity of flood-tide over the lands, which you say have been dammed out above, while that existed the harbour of Rye was deep in consequence of the scour from such a quantity of water?—I have no doubt that it was deeper than it is now.

2627. If the same principle is applied now would you not deepen the harbour by increasing the flow, and, consequently, increasing the scour?—Yes; but I cannot make this Board understand the exact difference between great things and little in that respect; for what you think would be a great thing in doing is that which I think would be a very little one.

2628. Is there not a principle upon which you propose to act, and is not that principle to remove, as far as possible, impediments to the flow of the tide, with a view of obtaining the largest quantity of scour out on the ebb as formerly existed?—Yes, that is true in the abstract. I state if you could do that, that it would do well for a considerable time. All you can do would cost a great deal of money, and have very little effect. My thoughts about these things are not only upon whether they can be done but whether they are worth doing.

2629. Then are the Commission to understand you to say that you do not disagree in the principle, but you think the expense of keeping up on a small river the agency of a large

scour would be more expensive than it would be useful?—Yes; and I mean to subscribe to the principle which you mentioned to this extent, that I seldom recommend internal waters to be embanked that are covered by a neap tide.

2630. That is to say you would allow the full flow of the flood to give the benefit of the ebb scour in every case?—Yes; and I mean to go on to say that above Scot's Float Sluice you will find some quantity of land that would not be covered by a neap tide, but which was formerly covered by every tide.

2631. In consequence of its being dammed out?—In consequence of its being raised by nature to a higher level than neap tide.

2632. If it was covered with water?—Yes.

2633. With tide water?—Yes.

2634. Do you consider that the level now is higher than it was before?—Not higher than it was when embanking, but higher than neap tide constantly when it was embanking. The last lands embanked continued to deposit itself, and they were nearly as high as spring tide. It is astonishing how fast land, when it gets above neap tide height, will rise on every tide until it will get to nearly spring tide height. There is nothing we can do artificially which is worth doing for a deep back-water channel. I have spent many thousand pounds in trying to do that which you are now recommending—back-water or reservoirs to secure harbours. All reservoirs to fill by the tide are of the same principle, that the river would be above Scot's Float Sluice. I can revert to other reservoirs which are higher than the highest water. The channel to the Bute docks is kept open by scouring, and scouring by the reservoir higher than the highest tide; but I fill that reservoir, not from the sea, but with clear water from the River Taff, brought some miles above on a level; but there are many modes of working the thing.

2635. Is it your deliberate opinion that opening up back-water to allow the tide to spread over any land is no advantage to the scour?—I must answer that question with a qualification. I say the principle of back-water is excellent if it can be maintained, and can be made worth its cost. My deliberate opinion is, and my advice always has been, that it is improper to embank any land which is covered by neap tide, which water is necessary to keep open a harbour. Times will arise when the land gets higher than the neap tide. I mean to say it is not worth while to dig out reservoirs for the sea to run into to make scour water, if that water has a tendency to fill them up again, as it has up the Rother; and if you were now to throw down Scot's Float Sluice, and make the banks higher along the River Rother up to Robert's Bridge, it would begin to lay a shelf of mud on the two sides until there would be scarcely rivulet enough to bring down the land water; and the effect would be that the land flood coming suddenly down the channel would be obstructed so much by the deposit that the flood water could not get down, but run over the banks.

2636. Do you consider there is any peculiarity in the River Rother silting up by the flood tide more than on any other river?—No; it is so on all heavily charged rivers, and where the shores on the river are flat.

2637. Then in that case it should be the study to keep out the tide?—In all cases where it is proper so to do; where all the circumstances combine to make that necessary. No one rule or principle can be found to fit all cases. There is no engineering so difficult as harbour engineering, about which every one thinks he knows something, and the moment he begins to apply one particular principle to all general cases, it fails in 99 cases out of 100.

2638. You mean to say that each harbour, from its formation and locality, have peculiarities that require to be studied before you can act upon any general principle?—Yes.

2639. Are the Commission to understand you to say, as a general principle, that it is desirable not to exclude the tide water which has flown and covered land by the neap tide as you say?—As a general principle, where you want a scouring power, or a tide to do good, and a harbour through which water passes in the flood, you should never embank any lands above that harbour which are covered by neap tide, because every cubic yard of water which goes in, goes back again, and helps to keep the channel open.

2640. Are the Commission to understand that inclosures in the land stopping the flow of tidal water, must gradually injure the bar of the harbour to which that formerly served as a scour?—Yes, it will do so; and moreover, if it is not done by art, it will soon be done by nature.

2641. In what way can art in these cases assist nature best?—Art can assist nature best if the channel gets crooked by endeavouring to keep it straight. If it gets uneven in its depth, art can assist nature by endeavouring to keep the bottom even.

2642. You mean where eddies may have formed?—Yes. If the Rye Harbour people had had money enough, they would have had a better harbour by this time. They have got engineers among themselves, and what one man proposed, another man opposed, and so they have gone on to the present day.

2643. Then you consider the harbour has suffered by not having one continuous authority to direct their proceedings?—I think so.

2644. What is your opinion generally on the harbours you have visited with regard to the improvements that have been made; do you consider, that generally speaking, harbours have suffered as much by neglect as by attempted improvements?—They have both had their share in making harbours bad, but still many harbours in this kingdom are much improved from what they formerly were by engineering.

2645. Considering harbours to be works for national purposes, would it be proper in your opinion that the Government should have control or superintendence over all attempts to improve or interfere with the harbour?—They have a good deal of control as it is, and very little power of doing good. They have power to do evil more than to do good, I think, at present.

Mr. *W. Cubitt*, C.E
July 2, 1845.

2646. What powers do you allude to that are wanting to enable them to do good?—To enable good to be done if we take all the harbours in the kingdom, and apply them to national purposes, or otherwise, there should be one head or one Board as a branch of the Administration, and that of the highest possible character, and with sufficient funds at its disposal.

2647. You mean that a central Government Board acting with adequate authority should have a general superintendence of the harbours of the country?– I think that would be exceedingly good and very useful if properly administered, provided it was not made a jobbing Board.

2648. You consider that the Superintendent of such a Board ought to have the power to command the highest talent in the country?—Yes.

2649. What are the particular powers now that would enable a Board so formed honestly to carry out that which would be best for the interest of the navigation?—It is a very difficult question to answer. I sometimes see good done by those powers of the Admiralty, and I sometimes see evil done; it is a sort of power with which they may do mischief, but cannot do good; they have not much capital at their command to do good with.

2650. You mean to say that a Board so formed ought to have at their disposal means of assisting a local fund, or perhaps even without that assistance carrying out such measures as might be pointed out by science to improve the navigation?—I think they should have means of assistance. There are means of assistance now possessed by a Government Board, but in such a questionable form, that although I have known it do good, yet I have known some evils arise—I mean the Exchequer Loan Board; there are means of getting money to do certain works for improving the harbours and roads, or anything else. It should be a Board that did not change with politics.

2651. A permanent Board?—A permanent Board of the highest standing.

2652. From your observation in the different places where you have been, have you seen any disposition in a local Board to study more the immediate advantage at the place or of the time than the general interests of the port as a place for navigation?—The means of the local Board are always limited; they have no power to do anything except taxing commerce, and then there always comes a battle about that, with the different interests; and then if they apply to Government, the Government have no means, except by granting an Act of Parliament, to levy tolls and dues and so on.

2653. Do you consider that it would be an advantage that the Admiralty or a Superintending Board should have the power of naming a certain proportion of the acting Commissioners on the spot to prevent selfish local interests from interfering with national objects?—That is done now; I have to do with a harbour occasionally where that is carried out, that is, at Edinburgh and Leith; there are Government Commissioners there put in and at some other places.

2654. What is the inconvenience you observe; is it from a divided authority?—It makes a divided Board of it, generally speaking.

2655. Have you not seen, on the other hand, great evil arising from the local Commissioners allowing land to be inclosed, and jetties and obstructions to be raised which it was their duty to have prevented?—I cannot call to mind any particular cases; I have seen cases where things have been refused which could have done no harm, and others granted which would do a great deal.

2656. By the local authorities?—Yes.

2657. Then in what way could you suggest any better means by which these Boards would be obliged to attend to the national objects which harbours ought to be?—It always comes to this, what can we get by doing such and such a thing? That is the question. If a port wants improvement, those whose interests it lay in having it improved, will associate together and talk the matter over, and they say, if such and such a thing is done, this would be made a good port. They call in the engineer to state what it would cost; he will tell them to the best of his ability, something or other which may be very short of the amount. They go to Parliament to get power to make improvements and levy dues, and so on, in order to raise a capital for executing the works. It frequently happens that when they have got their powers and money, and expended what they have got, that they generally come short, and there they stop; there is not sufficient trade to pay the cost, and if there is not trade enough to pay the cost, who has any interest in going on with further expenditure? therefore the improvement necessarily stops, and Government, unless it is for express Government purposes, for national improvement or defence, or something of that sort, Government has no interests in private harbours, which may be merely to bring a few coals, or carry produce out; they have no interest in that directly.

2658. Is it not a question of great importance to any Government, looking to the coast of this country, surrounded by so many ships, to have places of refuge in the event of war, or bad weather. Is it not on that account a national object of great importance, to make every harbour as good as they can?—I think it is, but those things are only in degrees as harbours of refuge; there are few places where harbours of refuge could be made, and where they are made they cost a great deal of money.

2659. (*Capt. Washington.*) With reference to Rye Harbour, would you not, seeing there is a difference of 11 feet in the rise of the tide between the town and low-water edge in the bay, would you not recommend dredging the harbour, and up to Scot's Float Sluice?—Yes.

2660. Thereby would you not gain that great reservoir of scouring water in the channel of the river itself?—Yes.

2661. Would not that be of use in keeping away any tendency to form a bar at low-water mark, which there now is?—It would.

2662. If we dredge two miles in the bed of the river, above Scot's Float Sluice, should we

Mr. *W. Cubitt*, C.E.
July 2, 1845.

not get great additional scouring power?—No, very little; you would obtain much more effec by regulating the channel from Scot's Float Sluice, down to the harbour mouth, and straighten ing that, and carrying out the eastern work down to the low-water mark; all that could be done for comparatively little money, and you would have a continually increasing good harbour.

2663. Do you not think that the pier should be slightly curved in going out to low-water mark, or would it be better straight?—It depends on circumstances, as to the state of the tide at the place. In that place I think a straight one is best, or it might be convex instead of concave.

2664. Convex to the westward?—Yes; whereas in some other cases it is necessary to make them curve towards the centre; local circumstances there come into play again. In that case I think the straight one would be the best.

2665. Are you not of opinion that a depth of 20 feet at high water springs may be obtained in Rye Harbour and maintained?—I think 18 feet may be maintained at Rye at high water springs.

2666. (*Chairman.*) Is there any difficulty in the proposed railway crossing the River Rother above Scot's Float Sluice?—I cannot explain all the difficulties now, but going from the present line would be attended with greater difficulty than in going in the present line, because, if we were to cross above Scot's Float Sluice, we should have to tunnel considerably. All alongside the river is a steep cliff, and there is not room, if I recollect right, between that cliff and the river to carry the railway clear of building property. Keeping outside the river, it came nearly at right angles to the stream at both places, and there was no remonstrance against it at the time from the parties interested in it that I heard of.

2667. (Mr. *Hume.*) On public grounds?—As things now stand, I do not think on public grounds it makes sixpence difference.

2668. You do not think there is any chance of the harbour becoming, as it formerly was, capable of receiving a greater number of ship?—I am sure the parties, if they had the power to make the railway where it is laid down, would very readily bind themselves to alter it if such a state of things occurred.

2669. (*Capt. Washington.*) Are you aware that it is less than a quarter of a mile from the harbour where all the ships lay, and not above a mile and a-half from the sea at high water, and exposed to the swell of a south-westerly gale?—Yes; and I am aware of many places where works are in the same position. London Bridge is not a quarter of a mile from where the ships lie.

2670. (*Chairman.*) The object of the Commission is to prevent the navigation from being impeded, and if this railway is allowed to cross so low down, it is obvious that all navigation would be entirely stopped—can you suggest any other way?—I can suggest another way by saying the railway might cross higher up, but it does not follow that the railway should be stopped. We have already in this country swing bridges in contemplation, and some executed, and in Holland there is little else for railways. They can take no line but the one proposed without stopping the thing altogether, I believe. That is the way the parties stand for this Session. I myself see no reason at present why all the navigation could not go on through an opening bridge that has gone on, and all that ever will go on.

[*The Witness withdrew.*]

Mr. *John Peter Fearon*, Solicitor to the Eastern Counties Railway,
Mr. *Peter William Barlow*, Engineer to the Ashford and Hastings (Branch) Railway,
} sworn and examined.

Mr. *J. P. Fearon* and Mr. *P. W. Barlow.*

2672. (*Chairman.*) (To Mr. *Barlow.*) Will you point out on the map the course the intended line of railway was to take across the river as now proposed?—The line in black is the line now proposed by the Company.

2673. Are there two railways before the Committee which intend to cross about the same part of the river?—Yes.

2674. What are their names?—The South-Eastern line from Hastings to Ashford, and the Brighton Company's extension of their Lewes and Hastings line.

2675. For which do you appear?—I am the engineer for the South-Eastern line. In consequence of the order of the Admiralty, directing that no passage of that river should be allowed below Scot's Float Sluice, I come now to ascertain the nature of the objection, in order to see whether it can be remedied, and to explain the kind of bridge that is proposed, in the expectation that it will in a great measure remove the supposed difficulty. The description of bridge will be a swivel bridge, with 30 feet opening.

2676. Our object being to prevent any impediment to the navigation, and at the same time to offer no unnecessary impediment to the railway, will you explain to the Commission how you propose that the railway shall cross so close to Rye without impeding the navigation?—It is proposed to cross by a swivel bridge of 30 feet span, and as much opening as possible in the river, so that there would be no impediment offered to the flow of the water; and it is very rarely that ships require to go up there, and when they do, they pass through the swivel bridge.

2677. (Mr. *Hume.*) What is the width from bank to bank?—250 feet.

2678. Do you propose any part of that to be solid, or all upon piles?—It will be as much on piles as possible, consistent with the construction of a swivel bridge. From the circumstance of its being a swivel bridge, it requires that considerable abutments should be made for the foundations of the swivel bridge to work upon. You might make it in one span if it were

Mr. *J. P. Fearon* and Mr. *P. W. Barlow.*
July 2, 1845.

not a swivel bridge; but if it is a swivel bridge, you must have the abutments for the swivel bridge to work upon.

2679. How much of the 250 feet of water way would you take up by the two abutments?—30 feet.

2680. (*Chairman.*) 15 feet on each side?—Yes; there would be two abutments which the swivel bridge would work upon, and one or two rows of piles besides to support the remaining part of the bridge. I reckon 30 feet would be sufficient to take out of the water way.

2681. (To Mr. *Fearon.*) Would you be prepared to consent to the insertion of a clause in the Bill binding the Company, in the event of any serious injury occurring to the navigation by this bridge, to turn the line so as to cross above the sluice. In the event of Rye Harbour being improved in such a manner to make it of more importance, would there be any objection on the part of the Company to consent to the insertion of such a clause as would bind them to cross the river higher above?—I should think not; but I should state the feeling of the South-Eastern Board is, supposing this line to be made, they would have the deepest possible interest in the well-being of the harbour of Rye. So far from allowing any impediment, they would very willingly assist in improving that harbour, which they have always thought capable of improvement.

2682. (Mr. *Hume.*) Supposing it should be afterwards found, by the increase of the shipping and any accident likely to happen, would you oblige yourselves at a future period to undertake to vary your line and take it on the other side?—(Mr. *Barlow.*) I am not aware of any objection to that.—(Mr. *Fearon.*) I have no hesitation in saying, on the part of the South-Eastern Company, they will accede at once to such a clause. I perceive that that must be a condition, and if they do not accept that clause, there is an end of the Bill; there will be an end of it unless we get your consent.

2683. (Mr. *Godson.*) (To Mr. *Barlow.*) Is there room between the cliffs in the river for you to cross above the sluice, supposing you were ordered to do it at a future day?—I have looked to that point; it might require more cost.

2684. Would it require a tunnel?—No, I think not.

2685. (Mr. *Hume.*) Then we understand you to say a swing bridge is proposed of 30 feet width of water way, including the piles and abutments?—Yes.

2686. (To Mr. *Fearon.*) You are prepared to make some offer with respect to improving the harbour?—If this Commission can suggest any plan by which the harbour could be really and usefully and permanently improved, the South-Eastern Company will be very ready to contribute 10,000*l.* towards that object, supposing it proved to your satisfaction that it would really be doing the thing effectually; because what every one has felt in that quarter is, that vast sums of money have been spent to no purpose.

[*The Witness withdrew.*]

Adjourned.

Wednesday, 9th July, 1845.

Present:—

Capt. Sir GORDON BREMER, K.C.B., in the Chair.

Mr. HUME, M.P.	Capt. BEAUFORT, R.N.
Mr. A. CHAPMAN, M.P.	Capt. WASHINGTON, R.N.

J. S. Russell, Esq., F.R.S.
July 9, 1845.

John Scott Russell, Esq., F.R.S., examined.

2687. (*Chairman.*) Will you be so good as to state your profession and place of residence?—I am an engineer, and live in London.

2688. The Commissioners understand that you have devoted your attention to the construction and improvement of tidal harbours?—I have made a good many experiments upon the subject.

2689. Will you state what tidal harbours and rivers you have examined and reported upon?—The Dee, the Mersey, the Clyde, and the Tay, are the principal I have either examined or reported upon. I have examined recently several, of which the report is in progress, written, but not yet published.

2690. (Mr. *Hume.*) What are the chief obstructions to the tide which are found, and in what way do they operate?—That is probably the point into which I have gone most fully in these observations. They were made for the express purpose of determining what the causes of the retardation of the tide were. It appears that the retardation of the progress of the tidal wave in ascending the channel of a river is not dependent, as was supposed, upon the mere area of water way, as it has been called, but chiefly upon the element of the depth of that water way, so that I found where the water way of the channel was most capacious, the tide suffered most impediment, and that in other cases where the channel was very much smaller, the flow of the tide was much more accelerated; so that I believe the one important point which these observations have served to bring out is this, that where the mean depth of the channel is greatest, independent of the area, the progress of the tidal wave up the river will be the most accelerated. There were some very strong cases of that which I found in my observations upon the Clyde. Some portions of the channel were of considerable width, and others were considerably deeper, and the shores, instead of shelving with a greater slope, were comparatively perpendicular, and it was found that the velocity of the tidal wave was considerably greater

where the channel was narrow and deep, and where the sides were nearly perpendicular; that that was the form which was most favourable for the progress of the tidal wave. In the other case the spreading shelving banks seemed to impede the progress of the wave, although they gave a much larger area of water. The experiments which I have made prove that the tidal wave is propagated according to the same law as the wave called a wave of the first order. Now I have found in the wave of the first order, and in all tidal waves that I have examined, the velocity of propagation of the tidal wave is proportioned to the square root of the depth, and it is because the tidal wave is a wave of this order, that its speed is proportioned to the square root of the depth; therefore that so far as a mere matter of generalized fact that the velocity of the tidal wave is proportioned to the square root of the depth; but I can give a few numbers here which will state exactly what the velocities observed of the tidal wave are in all depths of channel. My experiments upon tide and other waves have been of 10 years' standing in those rivers which I have already mentioned, and in artificial channels which I also constructed for the purpose of comparing with them. My first object was to make experiments on different channels, some of them artificial and some of them natural channels, in order to ascertain what law the propagation of the wave followed, and I found that I could, supposing the bottom level, determine with the greatest precision the velocity of the tidal wave when I knew the depth of the channel, and the following are the results:—In 10 feet depth of water I found the velocity of the tidal wave to be 12 miles an hour; 20 feet depth 16 miles an hour; 30 feet depth 20 miles an hour; 50 feet depth 26 miles an hour; 70 feet depth 32 miles an hour; 100 feet 34 miles an hour. I made the same experiments in a channel of the same depth, but shelving gradually to the bottom, and I found the effect of that contraction arising from the shelving sides which virtually diminish the mean depth, though they do not diminish the greatest depth, to be to reduce the velocity of the tidal wave to just one-half; and I found that that was not owing to the dimension, because if I made the channel twice as large by widening it, still if it sloped uniformly, however wide I made it, I never increased the velocity of the tidal wave so long as the greatest depth remained unchanged.

2691. Can you explain how that is?—The principle of this is fully explained in the report on waves made to the British Association for the Advancement of Science in 1844.

2692. Will you explain in what way the tidal wave is retarded by shallows in the bed of the river?—I find that in the deep part of the river the velocity of the tidal wave is that which is due to the depth, as given in the above table, but that the moment it comes to the shallow part it moves only with the same velocity through that shallow part as if the whole length of the channel were only of the shallow depth. It retains none of the acceleration in that shallow part which it had acquired in going through the deep part of the channel; it instantly accelerates its velocity by precisely the velocity due to that depth, however great it may be; so from shallow to shallow, every shallow that it crosses, it may be considered for the time being as a shallow river of that depth.

2693. (*Capt. Washington.*) By means of the table you have referred to, could you, by knowing the velocity of the tidal wave, predict approximatively the depth of water in the channel of a river?—Yes.

2694. (Mr. *Hume.*) If that is a principle which you have established, does it not follow that the best means you have of improving the navigation is to remove every such shallow, however small it may be, and render the volume of water as nearly rectangular as possible?—That follows necessarily.

2695. From the observations which you have made in the different rivers you have named, have you had an opportunity of proving the correctness of this principle?—I have had tidal observations accurately made before and after the date of such alterations, and in every case the acceleration of the tidal wave has corresponded very directly with the increased depth of the channel.

2696. What effects are produced on the flow of the water at these places where shallows are produced, or where shallows are removed?—The first effect of a shallow part in a channel is to keep back the time of the commencement of the flood much more than it keeps back the time of high water; the consequence of which is, that it diminishes very much the total time of flow up the river, the whole period of flood is very much shorter, and in consequence of this effect on the length of time of the flow, the total quantity of water carried up the river is very much diminished; not only is it very much diminished, but the rapidity of the flood current is very much increased while it lasts, and the duration of the ebb is very much lengthened; the consequence of that is, that there is a much greater tendency to carry up obstructions, and fill the river by the flood, than there is to clean it by the ebb.

2697. Are there not retardations by projections on the sides of the river?—There are. I find that the chief effect of lateral projections or inequalities on the banks is simply to retard and to break up the flow of the tidal wave, so as to diminish very much the quantity of wave which enters a river, but without affecting materially the time of the progress of the wave.

2698. Do you mean that it prevents that quantity of water from flowing up that would flow if the banks were smooth and continuous?—It does.

2699. In what way have you seen these principles exemplified in the case of any of the rivers that you have visited?—The first case in which I have seen the results of those observations verified is the case of the River Dee; that, I think, is the most notorious case with which I am acquainted. I have some very old plans of the River Dee in the middle of the last century, in which I find the progress of the tidal wave through the deep channel direct to Chester to be very rapid, and the flow of the water up the river very great, but some time ago the River Dee Company diverted that river from its former course, and turned it into an extremely narrow channel, a kind of canal; in that canal I made observations which showed that the

J. S. Russell, Esq., F.R.S.

July 9, 1845.

velocity of the tidal wave in this part of the channel so turned into a canal was in exact conformity with the table which I have just given in; but immediately below that the channel spreads out into a wide and shallow and crooked course; and there I found the velocity of the tidal wave, although in a much wider channel, very much retarded by the shallowness of the Dee. I consider that also to be a case in which the immediate interference of some power or other is necessary to prevent the entire destruction of the channel; for in 1836, I had an opportunity of observing how injurious a very small obstruction might be in totally changing the channel of the river. I found the river issuing from this canal, and going straight down out of this channel to a place called Flint; and I found that the course of the deep part of the river had for a long time kept straight along the coast until some proprietor chose to reclaim a piece of land in the immediate vicinity of Flint, and extended his enclosure into the water-way; I was able to trace then most clearly the former path of the river previously to this projection, although it has since been entirely obliterated.

2700. In what year was that?—It was in 1834 or 1836. This projection was extremely small, but a strong one, and such has been the effect of that projection as to divert the course of the river through a space something like a mile and a half, diverting it nearly at right angles across the estuary out of its former path, so as to ruin altogether the harbours which were originally established upon the south side of the coast without giving the opposite coast any benefit, for it did not turn it to the opposite coast, it merely turned it through the extensive sands of the estuary, and above that point it had an equally injurious effect for 3 or miles up; for instead of one channel on the south side, as formerly, it branched off in various directions.

2701. (*Capt. Washington.*) Has the obstruction been removed?—No, it has not.

2702. (Mr. *Hume.*) What effect has that had on the navigation?—The effect is such that there is now no defined channel whatever above Flint between the mouth of the canal, which the Commissioners made, and Flint Castle.

2703. What is the distance?—About 5 miles.

2704. You consider that to have been produced entirely by the small enclosure projecting into the river on the south side?—I do.

2705. Do you consider, upon the principle upon which the stream has been turned, the removal of that encroachment might bring the current back to its old course?—With some additional works I have little doubt it would. I have little doubt that the Dee might be restored to a tolerably straight and good navigable channel, and that it might be made a good tidal river.

2706. Have you examined the distance from Chester to the sea, and are there any other impediments exemplifying the principles which you have now laid down?—I am not aware of any other considerable impediment except a rock which is at some distance above Flint, which also interferes with the flow of the channel.

2707. Have you made any report on that river?—Yes; I made a report to the Improvement Commissioners of the river Dee.

2708. Have they acted upon it?—They endeavoured to obtain an Act of Parliament, but they found the proprietors of land in the vicinity opposed to the improvement of the river.

2709. Do you consider that if the whole of that navigation was cleared in the way you could point out, the river could be made navigable for vessels with ease up to Chester?—I have not the least doubt that Chester might be restored to its eminence as a port.

2710. Was it ever of great eminence as a port?—It was of such eminence as a port that large vessels could come up and ride under the walls of the fort.

2711. At what period was that?—During the early part of the last century.

1712. What sized vessels can go up to Chester?—The largest sized vessel that finds its way to Chester is in extremely high spring tides, and then only draws from 7 to 9 feet of water.

1713. Have you made any estimate of what the expense would be if power were given by Parliament to make Chester the harbour you point out?—An estimate was made at the time of the expense only of such partial improvements as the Commissioners would be able readily to accomplish, but we found a material improvement could be made for an outlay of 50,000*l.*

2714. Who are the Commissioners?—The Commissioners are inhabitants appointed as Commissioners for the improvement of the river Dee.

2715. You have stated that the Chester navigation at one time admitted vessels of considerable size up to the city: can you state from your observations of the river what are the causes of the injury that has taken place?—Besides the cause I have already mentioned, there can be no doubt that the entire ruin of that estuary has been owing to the injudicious reclaiming of land to an enormous extent by a large Company formed under an Act of Parliament for that purpose.

2716. In what year?—I think about 1750.

2717. Was that Company promoted by the inhabitants of Chester?—No; it was a private Company of totally different individuals, and under the Act of Parliament certain powers were conferred upon the said Commissioners of the City of Chester, of whom I have already spoken, with the intention of enabling them to provide for the navigation and keep it open; but their powers are totally ineffectual, the provisions are not adequate for the purpose.

2718. Do you know whether any reference was made to the Admiralty, whose duty it was to protect that as a tidal harbour?—I have not heard of any such reference.

2719. Can you state how high the tide rises at Chester?—The tide, at spring-tides, does not give more water up to Chester than than 9 feet 6 inches.

2720. What is the depth of water at the mouth?—The depth of water in the lower part of the river is capable of taking up the largest ships of any class that you would wish to take up.

2721. Can you state how high the tide rises at the bar, and how high at Chester at ordinary spring-tides?—The tide rises at the bar 33 feet, and at Chester it is what I have already stated, for it is all but dry at low water. *J. S. Russell*, Esq., F.R.S. July 9, 1845.

2722. Do you know what the difference of rise in the bed of the river at Chester is as compared with the rise at the mouth?—At Flint the tide rises fully as much as it does at the mouth.

2723. Then if proper engineering works were applied between Flint and Chester, to what extent could the navigation be deepened up to Chester?—I have no doubt that by works of even moderate extent, 22 feet of water could be secured to the town of Chester.

2724. Would you in that case apply the principle of deepening the channel so as to give the greatest cube, on the principle you have already laid down?—Precisely so; I should endeavour to obtain the greatest mean depth throughout.

2725. Would you also, as regards the banks of the channel, endeavour to narrow them to resemble as much as possible a canal?—I would do so, with proper provision, however, for maintaining as large a quantity of flood surface as possible, on account of the bar.

2726. How far is the bar of which you have now spoken from the Point of Ayr?—Five miles, and that bar lies north-west from Ayr Point Lighthouse.

2727. What is the depth at low water in spring-tides on that bar?—12 feet.

2728. How high does the tide rise on the bar?—33 feet in spring-tides.

2729. Consequently there would be upwards of 40 feet on the bar at spring-tides?—Yes.

2730. You have stated that large quantities of tidal lands have been reclaimed since the middle of the last century; are you able to state what the depth of water at the bar was before that took place?—I am not prepared to say how much deeper it was upon the present bar, but from Ayr Point upwards, where it is now nearly dry, it was of such a depth that the largest ships could ride in it at all states of the tide.

2731. Do you consider that that change has been produced by the injudicious enclosing of tidal lands under the sanction of Parliament, to which you have alluded?—There can be no doubt of it.

2732. Is it your opinion that no permission, under any circumstances, ought to be given to diminish the volume of water entering any of our tidal harbours?—I think that should be most scrupulously maintained with a view of scouring the channel with as large a body of water as possible, and where channels are narrowed it should be done also in conformity with this principle. I think it quite possible to obtain a good deep rectangular channel for the progress of the tidal water-way, and at the same time to keep unimpaired the whole lateral area for the reception of the tidal water to produce the scour; this could have been perfectly provided for in the case of the river Dee, along with the narrowing of the channel.

2733. Do you mean to say that a considerable portion of land might have been enclosed, provided compensation had been made by an addition of water by deepening the channel?—Perfectly so.

2734. Is it owing to the want of that provision that the injury has been done to the harbour of Chester?—Solely to that.

[*The Witness withdrew.*]

Adjourned.

Friday, 11th July, 1845.

Present:—

Mr. HUME, M.P., in the Chair.

Captain BEAUFORT, R.N. | Captain WASHINGTON, R.N.

Mr. *James Walker*, C.E., F.R.S., examined.

2736. (*Chairman.*) Will you state to the Commission what tidal rivers and harbours you have examined and reported upon?—Yes; they are numerous:— Mr. *James Walker*, C.E., F.R.S. July 11, 1845.

Aberdeen,
Ardrossan,
Arbroath,
Barrow,
Belfast,
Bridlington,
Bude,
Burntisland,
Caledonian Canal, entrances,
Carnarvon,
Castletown,
The Clyde,
Cuxhaven,
Douglas,
Dover,
Dudden,
Dunbar,
Dundee Harbour,
Fraserburgh,
Fleetwood,
Granton,
Greenock,
Hamburgh,
Harwich,
Holyhead,
Hull,
Kingstown,
Leith,
Lowestoft,
Lough Swilly,
Lough Foyle,
The Mersey,
Montrose,
Newcastle,
Newhaven,
Newport,
Piel Harbour, in Lancashire,
Portsmouth,
Plymouth,
Port Glasgow,
Port Patrick,
Ramsey,
St. Katherine,
St. Sampson's and St. Peter's, Guernsey,
St. Helier's, St. Catherine, and other Harbours in Jersey,
The Severn,
Seaham,
Southwold,
Sunderland,
Thames,
Usk,
Wear (River),
The Welland,
Weymouth,
Whitby,
Whitehaven,
Whitstable,
Yarmouth,
The Yare.

Besides other rivers and docks.

Mr. *James Walker*, C.E., F.R.S.

July 11, 1845.

2737. In the course of your experience, have you been enabled to lay down any principle that is generally applicable to the improvement of tidal rivers?—No. I have found that each case must be treated upon its own merits. The object aimed at in rivers which depend upon the tide has always been to prevent as much as possible any diminution of the tidal water. Where the river depends on land floods, then the object has been not so much to trouble oneself with the tidal water, as to regulate the width of the river, so as to give uniform depth by creating an increased uniform velocity. The Clyde, which is particularly referred to, and upon which I have given evidence at great length before the House of Commons, and written various Reports, is as good an illustration of that case as any that could be given, because the upper part of the Clyde, I think, entirely due to the land floods, and the lower part, the estuary of the Clyde, entirely to the tidal water.

2738. In the first place, do you allude to those where bars are formed, for which you wish to reserve the greatest quantity of tidal water as an out-scour?—Yes; the object is the greatest quantity of water, where the bar is to be removed by the effect of tidal water.

2739. Are the Commission to understand that in every tidal harbour where a bar is an impediment to its navigation, your principle has been to obtain as great a quantity of flood as possible, with a view of increasing the scour of the ebb?—Yes, as a general principle; but there are tidal harbours in this country which do not depend much on the tide, even for the removal of a bar, but depend almost entirely on the land floods. I have lately had a case before me, to which I have given a good deal of attention, that of Whitby: it depends almost entirely on the land floods, and very little indeed on the tidal water; at the same time I have recommended that no encroachments be made even on the tidal estuary without proper notice being given to the Commissioners, and the encroachment being approved by them.

2740. Where you recommend narrowing and straightening the channel of any river, do you take into account the necessity of giving compensation for the diminution of tidal space by deepening, or in what way do you compensate for the narrowing which reduces the quantity of water?—All I said with regard to narrowing, was applicable to cases where the river owes its capacity to the land freshes. I have already said, that in cases where I consider the river to be the effect of the tide, my object as much as possible has been to prevent any diminution of the tidal water between high and low water. I need not say that any deepening below low water has very little effect in increasing the quantity of tidal water.

2741. Unless that depth can be made throughout so as to admit the flow of water from the lowest part?—If you make it deep, and that depth is below low water, the space below low water and the channel of the river is always filled with water, and that does not go out or in. Take the case of the river Thames. The removal of all the shoals which I have so strongly recommended in my Report of 1843, would have but little effect in increasing the quantity of tidal water that enters the river Thames.

2742. What are the chief obstructions then to the propagation of the tide which you generally find to exist?—Irregularities in the width, and a contracted channel.

2743. Not shoals?—Shoals also; but if they are under low-water not by an means to the same extent.

2744. After the water arrives to the same level at the head of the river as it does at the entrance of the river, then no removal of shoals would be an improvement?—Yes; the removal of shoals may still do good—the water at the head of the river may rise higher than at the entrance.

2745. Will you explain in what way these obstructions operate?—They operate the same as an obstruction in a pipe would prevent the liquid passing freely through it.

2746. Narrowing the capacity?—Yes; and in that way diminishing not only the volume, but the momentum.

2747. In what way would you increase the momentum?—By straightening the banks, removing the shoals, and giving a uniform width.

2748. Then your wish is on all occasions to keep the banks as wide as possible where the tide flows, but to have them uniform, if possible, which increases the momentum?—Yes, and to have uniformity, particularly where the river depends on the land floods.

2749. Then in what way do you best remove those obstructions?—If they are to be removed by art, the best way that I know of is by dredging, but more good probably has been done by the narrowing and regulating, and acting by an impulse on the channel, and when the worst part is taken away the velocity often does a great deal towards it without dredging.

2750. So that by a judicious application of those principles nature herself may remove a large portion of the obstruction which otherwise would continue?—Yes.

2751. Are you of opinion that depths in rivers, and their powers of scouring, are chiefly due to the volume of water brought down in freshes or the tidal water?—To both, as the case may be.

2752. Is there more fear for our rivers by the rubbish brought down by the stream, or to sand and silt brought in by the flood tide?—That is one of the general questions which depend on the particular case. I know rivers where the obstruction is very much caused by the breaking down of the banks and the debris being carried into the stream, and others where it arises from the sand carried in from the sea. I think the Thames is a case where the deposit is brought from the upper part of the Thames, the city, and elsewhere. Whitby is a case where the obstruction is entirely caused by the sand which is washed in from the sea.

2753. Can you state any particular instance where the application of those principles has been attended with success?—I think in every river I have mentioned, where I have been consulted, the same principles have, according to different modifications, been attended with success. The laws of nature are uniform, and what operates in one river would, under similar circumstances, operate in another. It is very fortunate for engineers that the application of those principles, like the application of other cures, requires the advice of the practitioner.

2754. Generally speaking, whatever interrupts the flow of water up or down is injurious to the channel?—I think not. Whatever interrupts the tidal water is injurious to the channel that is dependent on the tide, but the very cause that I have explained as the best way of improving rivers, which is by judiciously narrowing them and improving their depth, produces its effect, by forming an obstruction to the passage of the water.

2755. These improvements are to assist the stream by making the sides and banks uniform?—Yes; and in many of our rivers, the first improvement, where the parties have not been enabled to make the continuous narrowing, has been the carrying out jetties opposite to the shoals, and increasing in that way the velocity of the stream on the shoals.

2756. With a view of carrying walls from the jetties up or down to regulate the stream?—Yes, afterwards, when they can afford it. The Clyde was done in the jetty way when they had not money to do more, and they are now going on connecting the ends of those jetties.

2757. (*Capt. Washington.*) Would not the jetties have been sufficient without the parallel banks?—No, they would by no means have answered so well.

2758. Was not the original intention of Goulburn that those should suffice?—I dare say if Goulburn had had the question put to him he would have said, when you can afford to connect them do so, because it is evident the jetty only operates by increasing the velocity where the jetty itself exists, and for a short distance lower down; that in the space between jetty A. and jetty B. (going down the stream) immediately after jetty A. is passed, the river tends to resume its velocity, as if neither jetty A. nor jetty B. were there, or as if they were a great distance from each other. The best way, therefore, of getting an uniform velocity is to make a continuous line, or something that will have the same effect.

2759. Is there no rule you can lay down with respect to the place where jetties may be placed?—None that would be universally applicable. The plan lying before me is, I see, a plan of Barking Reach in the Thames. Suppose a jetty run out to the low water line from the south side from one point and another jetty at half a mile above it, the effect would be to increase the velocity opposite to each jetty, and therefore to remove the shoal which is marked on the plan before me as Barking Shoal, if it is a moveable material; but this mile between the jetties would scarcely be affected in point of velocity. I think it is quite impossible to lay down any general rule, the application of which would be so uniform as that an attempt to do so might not do more injury than good.

2760. Then each river and each locality requires to be attended to; but the principles which you have laid down should be always acted on?—Yes. Having had put before me this sheet of the River Thames, which has Barking Reach on it, as far as my recollection goes, Barking Shoal is peat on the surface, and therefore that is a case where dredging is wanted. That is one of the cases referred to in my Thames Report.

2761. Have you not, in your Report of 1842 to the Navigation Committee of the City of London, stated that Barking Shelf, commencing opposite the creek and continuing nearly half a mile down, and extending nearly two-thirds of the river, with water only from six to ten feet in the line of the navigation, that that you consider the worst shoal in the river, and yet it might be removed if proper means were employed?—I have.

2762. What are the means you would employ?—Dredging the peat or rock away, and then either the Trinity House or the individuals who are desirous of having the gravel would take the remainder away.

2763. (*Capt. Beaufort.*) Taking for granted that gravel is under the peat?—Yes, which I believe it to be; I think you will find it generally so in the Thames.

2764. (*Chairman.*) Are you aware of any reason why that which is so important to the navigation of the Thames has not been removed as recommended?—The want of a party of some denomination or other with funds to do it; and I think it is much to be deplored that so very important a measure as the removal of those shoals, which are so injurious to the River Thames at present, should, for the want of 60,000*l.*, be left so long as they have been.

2765. In that Report it is stated that there are no less than 14 shallows or shoals from London Bridge downwards in the river, and that all of them might be removed without any difficulty if an expense of 60,000*l.* was incurred?—Yes.

2766. Have you any reason to alter the opinion you gave upon that occasion?—I have not. I have not entered into that computation since; but that was intended to be a fair estimate at the time.

2767. Could you furnish the Committee with any data as to the cost of dredging?—Yes; but in the next room you have an individual (Mr. English) who is better authority for that than I am. I speak from recollection, but I think it is probable that I took the dredging of the peat, the useless stuff, at something like 9*d.* to 1*s.* a cubic yard.

2768. In this Report did you contemplate making the depth of water in the River Thames 12 feet in all places, from London Bridge down to below Barking Reach?—Down to Gravesend.

2769. That, in fact, if carried out, would be clearing the river of all those impediments that now interrupt it?—Yes, to the extent of 12 feet at low water up to London Bridge, and a width sufficient for navigation.

2770. Is it your opinion, from the experience you have had in the difficulties that have been met in carrying out improvements, that in every river there ought to be one superintending power to direct all its operations where the interest of navigation is affected?—Yes. Before leaving the subject of the estimate of the river, I should say that I supposed the material to be of ordinary quality. There is some material in the river, a shoal called Whiting Shoal, near Limehouse, which is now being removed by the Navigation Committee, and for which the cost must be 5*s.* per cubic yard, for it turns out to be a natural concrete. A liberal allowance ought to be made for contingencies.

Mr. *James Walker*, C.E., F.R.S.

July 11, 1845.

2771. In the various harbours you have visited have you found the navigation more injured by neglect than by erections within the tidal waters?—I am not prepared to answer that question without looking into every particular case. I have no doubt that a great deal more good might be done to rivers than all the evils that have been done to them by encroachments.

2772. Take the case of Southwold Harbour?—Southwold Harbour has, no doubt, been injured by the neglect of the Commissioners, if the Commissioners existed at the time when the embankments were made, and on the other side by the activity of the parties who have enclosed the marshes. I have reported upon that river at great length. I think there have been no inclosures for nearly half a century.

2773. You have stated that there should be some general superintending power to manage the River Thames?—There is a superintending power to manage the River Thames; the Lord Mayor has the power, as conservator.

2774. Has the Lord Mayor sufficient power to carry out the improvements which you have recommended?—I should think he has, if he has the means. He is now removing Whiting Shoal, and the removal of Blackwall Rock, opposite the Docks, was done some 30 years since. There is power enough to remove the shoals at present, if there are adequate funds applicable to the purpose, and a determination to do it.

2775. Do you think that in a great commercial country like this that the clearing and improving of the harbour should be left to the Mayor of any corporation; should it not be the duty of the Admiralty, or some Board connected with the Admiralty, to see that the rivers are kept in proper order, and where they are not sufficient, to improve them, if possible?—That is a very large question. But suppose the case of a Mayor, or of a local Commissioner, or a local Board, whose immediate interest is to take care of the river, such for instance as the River Mersey: I think that the merchants and shipowners of Liverpool, who are the Commissioners of the River Mersey, are, with a professional man who knows what he is about under them, the most likely class of persons to be vigilant conservators of the river. A general surveillance or Harbour Board of Reference would at the same time probably be unobjectionable on public grounds.

2776. Then how do you account, in the case of the Mersey, for having allowed for 50 years a deep channel to exist, Victoria Channel, without their availing themselves of it until the Admiralty Surveyor found it out?—I am not aware of any proof of its existence for 50 years. The sands there are shifting; but the very accurate and excellent surveys made by the Admiralty have no doubt discovered shoals and channels in rivers. These surveys have done great good wherever they have been made. The discovery of evils is one thing; remedying the evils when they are discovered, is another. In the case of the Mersey, after the discovery was made by the Admiralty Surveyor, the trustees of the river immediately set to and discharged their duty very diligently, and I believe sufficiently, in marking out the channel, and deepening it, employing the same officer, Captain Denham, as their permanent marine surveyor.

2777. On that rule, ought not one of the first steps of the Government to be to have every port and harbour properly surveyed?—I think so, and that is being done. I hope that nothing will interfere with that very efficient and regular system which is now being followed up by the hydrographer in giving such excellent charts of every river where the tide flows, as well as of the coast.

2778. As far as these surveys have yet been done, they have been highly beneficial, and on that account you are of opinion they ought to be as general and as soon as possible executed?—Certainly.

2779. From what you know as the system adopted by the hydrographer under the Admiralty in obtaining surveys of the harbours, is that the best plan that can be adopted?—I think so.

2780. (*Chairman.*) Having made accurate surveys of a harbour, what are the steps you would recommend to improve or preserve it?—To have an efficient conservancy over it.

2781. Should not that conservancy be, as it is one authority under the Crown, to prevent local or selfish interests from interfering with a general trust?—Local interests may interfere with the Trusts on the one hand, and I find that members of Parliament having private and local interests, interfere with the Government on the other.

2782. The question is directed to whether an officer acting under the Crown without local bias, or without Parliamentary interference, is not a proper authority for preserving the rivers and harbours of the country?—Certainly, a very excellent officer for preventing the evils of local influence which you have referred to; but I am not at present prepared to give an answer, saying that I think it would be desirable for the good of the country that all the harbours of the country should be solely under an officer appointed by the Government. I have not considered the subject.

2783. Take, for instance, Southwold Harbour. What is your opinion with respect to the Trustees of Southwold Harbour, who are entirely local, landed proprietors chiefly?—For the last 40 years, I think, there have been no encroachments on the Southwold Harbour. I am to suppose, therefore, that during those 40 years the Commissioners have interfered to prevent encroachments. If the local interests were superseded, the ultimate evil arising from distance and other causes might be still greater.

2784. (*Capt. Washington.*) If 1500 acres of marsh land, on the banks of the river Blyth, lying below the level of high-water spring tide have been embanked, could such an abuse possibly have occurred, had there been anything like a conservator or Government officer to look after our harbours?—I believe there always was an officer, the harbour-master. Upon the subject of this river I have given my opinion that the embanking of so much of the marshes from the harbour has been an evil, but it must not from that be supposed that in all cases, or even generally, the embanking of land that is below the level of high water is an evil. The river Thames, from London down to its mouth, was at one time six times the present width,

and many thousand acres of land, which are eight feet below the level of high-water, have been taken from it; but the effect of that has, as regards the navigable part of the river Thames itself, been an improvement.

2785. (*Chairman.*) But in this case, the London river, an adequate breadth has been reserved for a channel?—Yes.

2786. But in Southwold that is not the case?—I do not think the evil in Southwold Harbour arises from the narrowing of the navigable channel. I do not remember having thought that it was too narrow, but it arises from the tidal estuary being diminished so as to diminish the back water that scours the harbour. Other professional men may differ from me; I have given that opinion very fully and very largely; my Southwold Report is printed; so that what I stated there deliberately is better than any evidence I can give at present, after a lapse of several years.

2787. On the principle you have stated respecting Southwold, has not the narrowing of the banks of the Thames, and diminishing the reservoirs for tidal water, had an injurious effect on the navigation of the Thames at its mouth?—It has had, in my opinion, the effect of increasing the shoals at its mouth; but the effect that it has had in improving the navigation of the river Thames itself upwards, is probably greater than the evil done by increasing the shoals, and that is just the case which shows the danger of laying down general principles, and acting upon them without knowing the particular case upon which you are advising, and taking the various interests into consideration.

2788. Upon that principle may not these shoals that have now increased below the Nore go on increasing until the navigation is interrupted?—No; I think unless you take some means to reduce very much indeed the tidal water of the river Thames the state of the shoals at the mouth of the river Thames have long since—centuries since—been in equilibrio with the disturbing cause. The surveys that have been made of the river from time to time show, I think I may say generally, that where there is an increase on one shoal there is a decrease on another.

2789. Then, in all the improvements you recommend for the Thames, you do not advise the decreasing of the volumes of water by the flood?—Not unless by the decreasing you can show you are going to do a greater good. Even in the Report for the Improvement of the Thames every embankment that narrows the Thames has the effect of in some degree of reducing the quantity of tidal water. Whilst I have recommended equalizing and narrowing in some places, I have also recommended deepening in others.

2790. (*Capt. Beaufort.*) Have you read Mr. Price's Report on Falmouth Harbour?—Yes.

2791. Have you had any evidence before you at any time about the nature of the bottom of the harbour?—Yes; but I forget what the nature of that evidence was.

2792. The question in Parliament at present is, as well as among people interested in harbours, on the propriety of allowing the dock to be erected. All are equally interested in getting Falmouth made into a good harbour, but the opposition people say, if they can scrape it out, there is no danger of its filling up again. Do you think there is any probability of that statement turning out to be well founded?—I do not think there is much danger. I do not think there is much sediment in Falmouth Harbour. I have reported my opinion to the Admiralty.

2793. What has produced those large banks that cover the whole of the inner harbour?—I cannot say, probably they always existed; there are natural irregularities below the surface of the water as there are above it.

2795. From anything you have seen since, have you any reason to alter the opinion stated in your Report on the subject?—No.

2796. (*Chairman.*) Have you been down to examine the spot?—No.

2797. (*Capt. Washington.*) Would it be safe to trust to a dredged channel keeping open?—It would. My advice to the Government about it would be to encourage it by all means, and let them do it. If considerable capital were expended in making docks, and they are obliged to dredge the way up to them, they will maintain the level, although at a future expense of dredging.

2800. Would you recommend that they should be called upon to give security for the completion of the works within a time to be fixed?—Yes, this might be, in cases, a prudent precaution.

2801. Will you state any time?—I should say seven years at least.

2802. What security should be taken, that if begun and not completed, they should be called on to remove the obstruction?—You must either take personal security, or as that which has been done in similar cases; for instance, in the case of building Vauxhall Bridge, a sum of 30,000*l.* was invested by the Company in the names of trustees, for the purpose of removing any obstruction in the river that should be made, and not to be surrendered to the Company until it would be sufficient to finish their bridge.

2803. After that was it given up?—Yes.

2804. If any portion of these dykes forming the docks are allowed to remain, supposing the works not to be carried out, would not that injure entirely the navigation up to Penryn?—If they formed an obstruction at all in the water-way they would. The velocity of the water is very small indeed.

2805. As the velocity of the water is not much, would there not be a greater tendency to silt and fill up from Penryn downwards?—The question is, whether that tendency would be increased by any encroachment on the stream.

2806. (*Chairman.*) Would not the tide from the dock upwards be entirely stopped?—Undoubtedly. The abstraction of the portion of the tidal water that will be taken off by the formation of the gates and locks for the purpose of making this part into a still or dock, is so far an evil. What I had to consider in giving that opinion to the Lords of the Admiralty was this, whether a greater good was not done to the commercial interest of the place by forming a

Mr. *James Walker*, C.E., F.R.S.

July 11, 1845.

large dock, than the evil done; and, in my opinion, the balance was decidedly in favour of the measure if completed.

2807. What sum of money do you think should be taken as security?—The projector's estimate being 230,000*l*., if from 15,000*l*. to 30,000*l*. were invested till they gave satisfaction to the trustees, I should think that would be ample for removing any obstruction.

2808. Is there anything in addition to what you have recommended in your Report of 1842, which you consider would be beneficial for the purpose of improving the navigation of the river Thames?—If the question refers to the parties who are to carry the recommendations into effect, I should say, that at present the improvement of the Thames seems to be a good deal hung up by a dispute between the Commissioners of Crown Lands and the City of London, in respect of the ownership of the soil of the river. While that dispute is going on, (and from all I can hear, it is likely to be a very tedious one,) the improvement of the river seems to be at a stand still; and the way in which it appears to me that it could be best carried on, would be by a Commission for the purpose of improving the river Thames, in which the different interests, the present conservators (the City of London), the Admiralty, the Crown Lands, the Corporation of the Trinity House, and the mercantile interest of London, would be fairly represented. I think if the Commission were of that character, formed by Act of Parliament (if an Act be necessary) that it would be extremely useful, and might go on with the improvements, while the two great bodies I have referred to are at law, with regard to the right of soil.

2809. Is it most desirable that that dispute, as to who is the conservator, should be settled as speedily as possible?—Yes; I believe there is no doubt of the Lord Mayor being conservator, but if a Commission, such as I have referred to, were formed, then the evil arising from the law-suit would not be felt. What I have now said has been a subject of conference at the Admiralty; I have also stated it to influential individuals of the city of London, and to the Commissioners of Crown Lands; and the late Secretary of the Admiralty, Mr. Charles Wood, was very much of the same opinion, and took an interest in the matter; I think the names of the Commissioners were being considered when the late Ministry went out.

2810. Do we understand you to state that pending this disputed ownership, the navigation of the Thames is neglected, and its commerce interrupted?—I consider it to be impeded very much, both above and below London Bridge, as respects improving it.

2811. You consider that under proper authority the river might be cleared from London Bridge down to Gravesend, so as to have 12 feet water at the lowest tide?—Yes.

2812. You see no difficulty in that?—No. No engineering difficulty.

2813. (*Capt. Washington.*) On your professional visits to Whitby last year, in company with the Admiralty Surveyor, did you not find that rubbish was commonly thrown behind the west piers, and was washed into the harbour by the flood tide?—I have stated that circumstance in my Report, to which I would refer the Commission. (*See Appendix*, p. 179.)

2814. Were not complaints also made of ballast being thrown into the harbour with impunity?—Not with entire impunity; the offenders were brought before the local authorities, and I believe threatened or admonished.

2815. Had you any evidence that that was done?—Yes; I stated that fully in my Report.

[*The Witness withdrew.*]

William English, examined.

2816. (*Chairman.*) What is your profession and place of residence?—I am partner in the firm of Hunter and English, millwrights, and contractors for dredging, &c.

2817. Have you been engaged in dredging the river Thames?—Yes; several parts of it.

2818. Are you now engaged on the Whiting shoal in Limehouse reach?—Yes.

2819. Can you give the Commission any data as to the cost of the dredging of the river generally?—The cost at present of dredging of the Whiting shoal is 1*s*. a-yard; we do not come to the solid stone, as we get to the depth wanted generally before we come to stone.

2820. Have you any rock in that part of the river?—Yes.

2821. What kind of rock?—Concrete, or plum-pudding stone, and solid stone.

2822. Taking the common shingle, can you give any notion of the expense of raising that per ton?—We put common shingle into barges at 5*d*. per cubic yard; the yard contains about 26 cwt.

2823. Do you deliver it also for that?—No, we only put it into barges for that; there is the lighterage, and the landing besides.

2824. How much would that come to?—It depends upon the distance to which it is taken. All the shingle we get is taken from above London Bridge; when we carry it down below, we pay to some parts 9*d*. and to some parts 1*s*. for the lighterage, and only 5*d*. for the raising, that is, 1*s*. 5*d*. per yard to take it down as low as Bow creek.

2825. Why are you not allowed to raise any below London Bridge?—On account of the Trinity House requiring a supply for the ballast of the vessels for themselves.

2826. Have you much demand for shingle?—In the middle of the summer there is great demand for it for the foundations of buildings.

2827. Do you sell it in that case?—Yes.

2828. Does the sale pay for the raising of it?—Yes.

2829. You are aware what price is charged for ballast by the Trinity Board?—No.

2830. Do you sell it for more than 1*s*. per ton above bridge?—If we do not do the lighterage, we sell it at 5*d*. per yard; if we take it down as low as Bow creek it is then 1*s*. 5*d*. per yard.

2831. Are you much employed above London Bridge?—Principally employed above London Bridge.

2832. Do you raise anything but shingle?—No; we cannot sell it if we do.

2833. Are there many parts and shallows where there is mud and peat, and matter that you cannot sell?—A great many.

2834. Suppose you were employed to clear the river from London Bridge upwards, so as to make a fixed depth at low water, taking a certain portion of the bed out regularly from side to side, what would be the expense you could raise it for; supposing you were called upon to remove it altogether for what sum could you do it, including lighterage and everything?—I cannot answer that question without I knew where we could deposit it, because if we had a long way to take it, there is so much more lighterage.

2835. Are the Commission to understand that now when you dredge above London Bridge you do so by permission from the Lord Mayor?—Yes.

2836. Do you confine your dredging entirely to raising gravel such as you can sell?—Entirely.

2837. Have you no directions given you to dredge in the shallowest places so as to form a channel in the middle?—We have this direction given to us, that we are not to go within such a distance of the shore; we are not to go now nearer than 100 feet of the shore each side. We apply to the water bailiff when we find we cannot dispose of the part where we are at work, and ask permission to remove to another place, pointing out where we wish to remove to, and he generally gives us leave.

2838. In no case do you remove silt or clay, or anything that you cannot sell?—No.

2839. Would there be any difficulty in making the bed of the river from Westminster Bridge downwards to London Bridge 5 or 6 feet deep at low-water all the way?—There would be no difficulty at all in doing it.

2840. Do you know what water there is at London Bridge at low-water now?—I do not. We did deepen at London Bridge at the request of the city, and took a good deal away.

2841. Of shingle?—No, it was principally Kentish rag that had been thrown overboard.

2842. Are the Commission to understand that all the dredging now is more for the material you want, than with a view to deepening and keeping the channel regular?—It is.

2843. Is it not a private speculation?—Yes. Where we are now employed at Whiting shoal the City pay us for it. The Trinity Corporation claim all that is fit for ballast, and they take it away; we put it in their craft.

2844. Do they pay you anything for putting it in their craft?—The City pay us.

2845. Do the Trinity Corporation take that for nothing which is raised at the expense of the City?—I believe so, but I am not certain.

2846. If it were desired to clear the river in the way that has been stated, and according to the plan of Mr. Walker, is there any difficulty in doing it except the expense?—Not that I am aware of, except at such places as Whiting shoal, where there is concrete and solid stone from 2 inches to 4 inches thick, and gravel, which creates some difficulty.

2847. Is there any other spot in the river where you think there is similar concrete?—Not that I am aware of. We meet with it, but it is thin above bridge, and we are able to tear it up.

2848. What is the power of your dredging-machines?—We have two dredging-machines of 10-horse each.

2849. What quantity could you raise in a day?—Of shingle and gravel we can load about 40 tons in half an hour with each machine.

2850. How many hours in a day can you work with your dredging-machines?—Ten hours.

2851. In that time how many tons could you raise?—600 tons. We can raise 40 tons in half an hour, but it takes some time to take one barge away when loaded, and to put another in.

2852. (*Capt. Washington.*) Does it take half an hour to do that?—A quarter of an hour on an average.

2853. Do you average 60 tons an hour throughout the day with each engine?—Yes, when it is gravel, and there is demand for it.

2854. You know the Trinity Board ballast-engines?—Yes.

2855. (*Chairman.*) What power are they?—20-horse each.

2856. How many of such engines have they?—Two; we only work two ladders, and they work four ladders.

2857. (*Capt. Washington.*) Suppose you were dredging the Thames in the way recommended in Mr. Walker's Report, how many engines would you use, and how soon do you think you could get the work done?—It would depend on the quantity, it would take several machines.

2858. (*Chairman.*) Supposing the quantity of cubic yards of soil to be removed from London Bridge down to Gravesend should be 1,200,000, how long would you be in removing that?—Four years, with two machines of 24-horse power each.

2859. (*Capt. Washington.*) What is the engine you have now got on the Whiting shoal?—One of 10-horse power.

2860. (*Chairman.*) What depth below low water are you engaged to remove Whiting shoal?—Fifteen feet below average low water.

2861. How do you fix the low-water mark?—There is a mark on the shore put up by the Navigation Committee, which goes up from one to so many feet; then we mark what we call our ladder, and look at the mark on the shore what depth to work the ladder to.

2862. What is the depth of the shoal you have gone through?—Where we are now we are not taking off more than three feet.

2863. What is the largest depth of shoal you have taken off?—In some places I think about five feet.

Mr. *W. English.*

July 11, 1845.

2864. What strata did you find?—The first stratum we find is gravel.

2865. How deep?—I suppose in some cases not more than six inches; after that clay, and that part is about 18 inches or 2 feet, then we come to a substance between a clay and a stone, and then we come to the stone.

2866. The stone is at the depth of about four feet below the bed of the river?—In different places there is more on the stone than four feet.

2867. What is the thickness of the concrete?—About six inches; when we get to the depth we leave off.

2868. What have you left off in?—We leave off generally in clay.

2869. To what extent is that shoal; how far does it extend?—I do not know the width of it; there is deep water on the further side, but not on this side. We are making a cut now, and intend to make a second cut of 150 feet wide the whole length.

2870. You mean a second cut from the side?—Yes, we are making a channel of about 150 feet.

2871. How long is the shoal?—From Blackett's Dock to near the end of the City Canal.

2872. How far is that?—About half a mile.

2873. Of all the dredging you have had in the river, is that shoal the hardest and most difficult?—Yes.

2874. How high up the river have you used your dredges?—As high as Wandsworth.

2875. Have you invariably found gravel?—Yes; but in some parts little gravel, and mixed with clay: it will not do for concrete, therefore we cannot sell it, and leave it.

2876. Do you mean that the gravel being mixed with clay and mud, it does not answer the purpose you want it for?—Yes.

2877. And therefore you do not raise it?—We do not raise it, and we then ask for leave to remove to another part.

2878. Your object being to obtain the article, and not with a view of deepening the channel?—Just so.

2879. You see no difficulty, if it was requisite, in deepening the whole river from London Bridge upwards to Wandsworth, so as to make it navigable?—No difficulty, except that in some parts there is very little gravel, and we come to clay, then it would be a higher expense, but still it can be done.

2880. Are there no limits fixed as to the depth you may go in search of gravel?—Yes, 10 feet below low-water mark, when we are not working near any bridge, but formerly I have dredged at 27 feet in some parts.

2881. The water-bailiff, then, is the person who gives you liberty, and fixes the place where you are to go?—Yes; when we find we cannot dispose of it, we apply to him to allow us to remove to another part, and mention the place where we wish to move to, and we generally obtain leave to do so, if it is not near any bridge.

[*The Witness withdrew.*]

Adjourned.

APPENDIX.

CONTENTS OF APPENDIX.

		PAGE
1.	Copy of Addresses, &c. for Returns respecting Harbours. Extracts from the Votes of the House of Commons (Mr. Hume)	143
2.	Extract from Report of Commissioners of Navy on the River Medway in 1818	143
3.	On the Rise of the Tide and Rate of Stream in the River Clyde, &c. (Mr. Bald)	144
4.	Letter from Mr. Bald to Mr. James Walker respecting the Lines of the Clyde	145
5.	Extracts relative to the performance of the Steam Dredging Vessels on the Clyde (Mr. Bald)	146
6.	Total amount of Soil dredged up from the bed of the Clyde from 1838 to 1844 (Mr. Bald)	148
7.	Letter from the President of the Chamber of Commerce at Rouen to Mr. Bald, and his Reply	148
8.	Extracts from Mr. Bald's Reports on Blackstone Moss and on the Clyde, in 1844	150
9.	Description of Bowling Basin on the Clyde	151
10.	Details of the Steam Dredging Operations on the Clyde, by Mr. Bald	151
11.	Extract from Acts of Parliament relative to the Glasgow Water-works	152
12.	Report on the River Tay, from an Admiralty Surveyor, on the east coast of England to the Hydrographer to the Admiralty	154
13.	Report by the Engineer of Dundee Harbour respecting certain encroachments on the bed of the River Tay (Mr. J. Leslie)	156
14.	Letter of Mr. Adam Burnes to Sir James Carnegie respecting embankments near Montrose.	159
15.	Mr. Rendel's Report on embankments on the South Esk, near Montrose	159
15*a*.	Memorial of the Trustees of the Harbour of Arbroath.	161
16.	Statement respecting the Forth Navigation to Alloa and Stirling (Mr. Galbraith)	163
17.	Letter of Captain Owen Stanley, R.N., on the removal of shingle from Spurn Point	164
18.	Statement of expense of Dredging at Yarmouth and at Perth	165
19.	Mr. Chitty's Opinion as to Embankments	166
20.	Extracts from Mr. Rennie's Report on Southwold Harbour	167
20*a*.	Mr. James Walker's Report on Southwold Harbour	168
21.	Report by an Admiralty Surveyor on the East Coast of England, on Southwold Harbour	173
22.	Abstract Opinion of Mr. Rendel on Embankments of Rivers	175
23.	Report by Captain Washington to the Secretary of the Admiralty on Harwich Harbour	176
24.	Report by an Admiralty Surveyor on the East Coast of England, on Whitby, Burlington, and Scarborough, addressed to the Hydrographer to the Admiralty	177
25.	Mr. James Walker's Report on Whitby Harbour	179
26.	State of the depth of the River Thames in 1680, 1732, 1805	183
27.	Report by Messrs. Stevenson, C.E., of Edinburgh, on the Improvement of the River Lune	184
28.	Statement relative to the River Dee, in Cheshire, by Mr. D. Stevenson, C.E.	186
29.	Serjeant Grose's opinion on the embankment of Wells Harbour	188
30.	Extract from Report on Rye Harbour, by Mr. C. Rand	188
31.	Ditto ditto by Mr. Rennie	189
32.	Ditto ditto by Mr. D. Alexander.	190
33.	Report of Mr. Cubitt on Rye Harbour	192
34.	Extract from Mr. Rennie's Evidence before the Rochester Bridge Committee in 1820.	193
35.	On Wexford Harbour, by G. B. Airy, F.R.S., Astronomer Royal	194
36.	Summary of the Income of the various Harbours in the United Kingdom	195
37.	List of Books presented to the Commission	195
38.	Captain Washington's Report on the Deposit of Silt in Dover Bay.	196

APPENDIX.

No. 1.

Extracts from the Votes of the House of Commons.

20th June, 1844, *page* 1246.

8. Harbours, &c.—Return of the several dues and charges of every kind levied on shipping at each port, harbour, or creek, in the United Kingdom; stating the rates of the several dues levied per ton on each vessel, and whether under authority of Acts of Parliament, and what Acts; whether by orders of municipal corporations, and of what date, or whether by charter, consent, prescription, or any other authority; so as to exhibit the entire charges of every kind on vessels at each of the harbours, ports, and creeks of the United Kingdom; distinguishing the several charges upon vessels taking refuge in the harbour only, from those upon vessels delivering the cargo, in whole or in part; and also on vessels in the coasting or in the foreign trade; distinguishing also the charges levied for local lights and beacons in each port (exclusive of those of the Trinity House, the Irish Ballast Board, and the Commissioners of Northern Lights), the charges for pilotage into and out of each harbour, and the charge for ballast; and whether under any and what Board the same are levied.—(Mr. *Hume.*)

16th July, 1844, *page* 1508.

22. Harbours, &c.—Petition of *Patrick Stead*, for inquiry into the constitution and qualification of the Commissioners of the Navigations and Harbours in the United Kingdom, as well as the state of the Tidal Harbours; to lie on the table.

23. Harbours, &c.—Address to Her Majesty, "that she will be graciously pleased to appoint a Commission to inquire into the past and present condition of the several tidal harbours, ports, and creeks of the United Kingdom, with the view of ascertaining the state of the navigation and the depth of water of these harbours, &c.; whether the depth of water was greater formerly than at the present time, and whether any and what extent of land over which the tide flowed at any former period has been inclosed; under what authority the several inclosures were made, the effects of such inclosures of land and of the erection of piers, jetties, &c., in decreasing the depth, or in improving or injuring the navigation of the several harbours, creeks, &c.; to call for and examine all general Reports of Civil Engineers and public Commissioners relative to the construction, improvement, or preservation of the several ports, harbours, creeks, and navigable waters of the United Kingdom which have been regulated by Act of Parliament since 1800, the operations under such Acts, and whether the result has been beneficial or injurious to the navigation of the said ports: also to inquire into the nature of the powers entrusted to the Board of Admiralty, under any Acts of Parliament, for protecting the navigation of the ports and harbours of the United Kingdom, and in what manner they have exercised those powers; and whether more extensive and more defined powers may be requisite to enable them to protect and to improve the harbours of this kingdom."—(Mr. *Hume.*)

29th July, 1844, *page* 1646.

38. Harbours.—Address for "Copy of the receipt of every harbour in the United Kingdom, for each of the last three years, stating the several heads of income, the authority by which the same are levied; and of the expenditure for each of the same years, stating the several heads of expenditure, and the amount of each head in each of those years."—(Mr. *Hume.*)

9th August, 1844, *page* 1748.

44. Harbours.—Address for "Return, by the Commissioners appointed under the several Acts of Parliament relating to the harbours and havens in the United Kingdom, stating the titles of the several Acts of Parliament, or Charters and Commissions, under which they have acted and now act; also copies of all maps of the harbour or port in their possession, and of all Reports made by engineers or other officers respecting the port or harbour; together with copies of complaints made to the Commissioners of the several harbours and ports of the defects of the harbours."—(Mr. *Hume.*)

No. 2.

Extract from a Report made to the Navy Board by a Committee of its Members appointed to inquire into the State of the River Medway.

"*Chatham Dockyard*, 10*th May*, 1818.

"We cannot therefore conclude without expressing a strong opinion that every encroachment upon a public harbour, however trifling it may be represented, should be viewed with the greatest jealousy; and seeing the injury occasioned in different harbours by apparently small encroachments, we think it highly worthy of consideration, whether it may not be desirable to revise and consolidate the several Acts of Parliament for the preservation and improvement of the royal harbours and rivers, and to invest certain of His Majesty's officers, resident in the vicinity of the harbours and rivers, with a power to prevent any such encroachments; and that the proprietors of the lands adjoining, or others, should be made liable to a fine, upon proof, before any magistrate, of having made or added to any hard, causeway, or other obstruction, without the permission of officers so empowered; but the details of any such regulations may be made a subject of future consideration.

(Signed) "T. Byam Martin, Rear-Admiral,
Robert Barlow,
Robert Seppings,
Commissioners of the Navy."

Appendix.

No. 3.

No. 3.

Extract from Mr. Bald's Papers on the Rise of the Tide, and the time of Ebbing and Flowing in the River Clyde.

Spring Tides.

The mean result of six observations, taken on the 18th, 19th, and 20th March, 1840, of the rise and fall of the tide at the following places, was as follows (full moon 18th March):—

	Hours.	Minutes.	Feet.	Inches.
Mean rise and fall of six tides in the harbour of Glasgow			8	4
Ditto at Clyde Bank, 5 miles 866 yards from Glasgow Bridge			8	0
Ditto at Bowling Bay, 10 miles 1166 yards from ditto			8	9
Ditto, 18 miles 1166 yards from ditto			10	5
Mean time of flowing in Glasgow Harbour	5	10		
Ditto of ebbing in ditto	7	13		
Mean time of flowing at Clyde Bank	5	15		
Ditto of ebbing at ditto	7	6		
Mean time of flowing at Bowling Bay	5	24		
Ditto of ebbing at ditto	6	56		
Mean time of flowing at Port Glasgow	6	6		
Ditto of ebbing at ditto	6	1		

Neap Tides,

Taken at the following places on the 25th, 26th, and 27th March, 1840.

	Hours.	Minutes.	Feet.	Inches.
Mean result of six observations of the rise and fall of the tide in the harbour of Glasgow			6	3
At Clyde Bank, mean of six tides			5	10
At Bowling, ditto			5	11
At Port Glasgow, ditto			6	1
Mean time of flowing at Glasgow	5	14		
Ditto of ebbing at ditto	7	16		
Mean time of flowing at Clyde Bank	5	43		
Ditto of ebbing at ditto	7	1		
Mean time of flowing at Bowling	5	52		
Ditto of ebbing at ditto	6	37		
Mean time of flowing at Port Glasgow	6	26		
Ditto of ebbing at ditto	5	59		

Extracts from Mr. Bald's Report on the Velocity of the Water in the River Clyde.

"The mean velocity of four sets of observations of the water passing down the Clyde, from the Harbour of Glasgow to the Junction of the Cart River with the Clyde, in ordinary fair weather may be taken at 1576 yards per hour, and the ascending current at 771 yards per hour; and from the Junction of the River Cart with the Clyde, to opposite Dumbarton Castle, the mean of five observations assigns the descending velocity of the Clyde at 1 mile 1069 yards per hour, and the ascending current at 1561 yards per hour.

"I have tabulated nine sets of observations of the velocities of the ascending and descending tidal and river current, from Glasgow Bridge to opposite Dumbarton Castle, a distance of 13 miles and 1120 yards, as follows:—

	Ascending Tidal Velocity per Hour, in Feet.	Descending River Velocity per Hour, in Feet.	Distance below Glasgow Bridge, in Yards.	Distance below Glasgow Bridge, in Miles and Yards.
				Miles. Yds.
From Junction of the River Cart with the River Clyde to opposite Dumbarton Castle :—				
Opposite Dumbarton Castle . .	3,525	8,677	24,000	13 1120
,, Dunglass Castle . . .	5,564	8,743	19,830	11 470
,, Donald's Quay . . .	6,866	8,828	17,333	9 1493
,, Rushalee Pier . . .	3,272	7,200	15,000	8 920
,, Centre of Newshot Isle .	4,200	9,000	13,000	7 680
One-fifth . .	23,427	42,448		
One-third . .	4,685	8,489		
	1,561 yards.	2,829 yards.		
From Junction of the River Cart with the River Clyde to the harbour of Glasgow :—				
1000 yards above the embouchure of the River Cart with the Clyde	3,600	6,000	10,333	5 1533
Opposite Scotstoun House . . .	1,600	5,142	8,000	4 960
200 yards below Crawford's Quay.	3,000	4,500	5,000	2 1480
600 yards above the embouchure of the River Kelvin with the Clyde	1,058	3,272	3,166	1 1406
One-fourth . .	9,258	18,914		
One-third . .	2,314	4,728		
	771 yards.	1,576 yards.		

" In the River Clyde during high floods, immediately below the harbour of Glasgow, I have found the velocities of the descending currents run at the rate of 2 miles 1613 yards per hour; and in the narrow parts of the river 3 miles 1148 yards per hour; this was in the middle of the river, and at the water's surface."

No. 4.

No. 4.

Copy of a Letter addressed to Mr. James Walker, Engineer.

Office of the Engineer of the Clyde,
Glasgow, 16, *Robertson Street, October* 26, 1839.

Dear Sir,

Your letter of the 24th instant I have received, and I now send you a perfect copy of the plan of the river Clyde improvement proposed by you on the morning previous to your departure from Glasgow, and on which the harbour lines are 450 feet in width down to the Kelvin, and narrowing at that point to 400 feet in width; and then continuing that width to near Renfrew Ferry, from which point it widens below.

The original plan is so covered with figures and lines, and some memoranda connected with the proceedings, that it has been thought better to retain it here, and to send you an exact copy, which the chairman has examined, and is satisfied that it is correct; you will perceive, by comparing the plans, that the one which the Committee have approved of has its lines laid out in such a manner as to save expense, both in cutting and in the purchase of land; and that one of its distinguishing features is that no part of the river channel of the Clyde shall be filled up, which will reduce the estimate of expense; and although the Committee have agreed to those lines and plan as being the best, they can hereafter, if it be judged proper, make the Clyde more direct in its course if found expedient to do so; power being proposed to be taken to the extent of yards on each side for this purpose.

In your letter of the 24th instant you mention " I have looked at the plan just sent, and with a trifling increase of the width which, as Mr. Turner informs me, the Committee have directed you to make, I cannot yet discover any difference between the plan now sent and the lines I laid down when in Glasgow without reference to any plan of yours."

I beg to say that the plan which I sent you with the lines delineated on it by me, and unanimously approved of by the Committee on the 16th and 18th instant, is quite different from the plan which you had designed and laid out when in Glasgow on the 12th instant, and which plan of yours was 450 feet wide from the harbour down to the Kelvin, at which point it was to be only 400 feet wide, and then to continue the same width to very near Renfrew. This plan of yours was peculiarly marked, and altogether different from any other plan that I had yet seen or heard of for improving the Clyde or any other tidal river; being a wide cylinder above and a narrow one below, a form calculated to prevent the tidal flow up the Clyde, which, in my opinion, would be highly injurious to the navigation, and the plan is characterized by proposing that several parts of the channel of the Clyde shall be filled up, and some large portions of ground cut away, and which I think was quite unnecessary. Mr.

APPENDIX. No. 4.

Logan's plan from the harbour down to near Renfrew was of an equal width, and it also proposed that several deep and large parts of the present channel of the Clyde should be filled up. But the plan sent to you on the 19th instant, and which had been unanimously approved of by the Committee was quite different from either your plan or that of Mr. Logan's, having a gradual increase of width from the harbour to the Cart, a form peculiarly favourable to a tidal flow up the Clyde; and it does not propose that any portion of the channel of the Clyde shall be filled up, or any large portions of ground adjacent to it be cut away for an increased width, when such can be avoided by substituting easy bends in place of nearly direct lines. These, in my opinion, are the points in which the merits of the plan consists, and which will insure its success through the Houses of Parliament if it should be opposed, because its form and shape can be defended by the laws of science; and also by those configurations which nature has universally assigned to every tidal river in the world. Whereas the plan of widening a tidal river above and narrowing it below would be the very cause of its failure in Parliament if opposed, were the design even to carry the illustrious names of Smeaton and Rennie. The plan for the improvement of the navigation of the Clyde must stand on its own merits if a contest takes place, for nothing else can sustain it or insure its success, although a different opinion is expressed on this subject.

With regard to the channel on the south side of the Newshot Isle, to which you have alluded in your letter, I have to express my very deep regret of any objection having been offered to its investigation as to whether or not rock exists in a small portion of its channel, because, until this is decided, I entertain a strong and a decided conviction, that it is not only the shortest, but in every point of view the best channel for the navigation of the river Clyde; and particularly so, as being much more favourable than the northern channel to receive and send up the full tidal flow; a scouring power, on which the preservation of the navigable channel of the Clyde will have chiefly to depend when it has been widened and deepened to the dimensions required. There is no engineering project which I have yet met with that I entertain so serious an idea of its being carried into execution than the opening of the channel on the south side of the Newshot Isle. Nor is there one improvement in the whole range of the river Clyde, more worthy of the attention and consideration of the engineer, or one that would be more useful in improving the navigable channel, and the tidal flow upwards, although you have, I think, without sufficient grounds, ventured to express yourself decidedly against it.

In concluding, I must assure you that my most earnest wish and only object is, that the best plan shall be adopted for the improvement of the Clyde, and that it may be one whereby all its capabilities may be fully developed, so as to afford every facility and accommodation to the rapidly increasing maritime prosperity of the port of this city.

The plan drawn out by me and approved by the Committee on the 16th and 18th instant, cannot be claimed by you, because it was the work of others, planned and made out after you had left Glasgow, and on a principle entirely different from anything you had recommended or even suggested.

I am, Sir,
Your obedient Servant,
WILLIAM BALD.

James Walker, Esq.
23, *Great George Street, Westminster, London.*

No. 5.

No. 5.

Extract from Mr. Bald's Papers of the performance of the Steam Dredging Boats in the River Clyde and Harbour of Glasgow.

The following statements have been taken from the official records of the Clyde trustees. But no account can be found in their books of the annual quantities of material which had been dredged up in the harbour of Glasgow and the Clyde previous to 1838, and which was one year before Mr. Bald was appointed engineer:—

Firstly. It is proposed to show the increased quantity which the four dredgers had dug up from the Clyde in 1839, 1840, and 1841, by manual labour, as compared to the quantity which had been dredged up by the same four dredgers in 1838, the year before Mr. Bald's appointment.

Secondly. The quantity which had been dredged up by the same four dredgers in 1842, 1843, and 1844, by the application of the propelling power as compared to 1838.

Thirdly. The quantity which steam-dredge No. 5 lifted in 1842, 1843, and 1844, when the propelling power was applied, compared to the quantity which she would have lifted by manual labour in the same time, deduced from the element of No. 5 dredge-boat's performance during the period of 30 weeks which she had been worked by manual labour in 1841.

Fourthly. The total quantities which have been dredged up by dredge-boats No. 1, 2, 3, 4, and 5, in the years 1838, 1839, 1840, 1841, 1842, 1843, and 1844.

Firstly. By manual labour there were dredged up the following quantities by dredge-boats Nos. 1, 2, 3, and 4.

In 1838	Dredged up	13,540 Punt Loads.	
1839	,,	14,217 . . .	677
1840	,,	19,516 . . .	5,976
1841	,,	18,443 . . .	4,903

Total Increase by Manual Labour . 11,556 Punt Loads.

Carried forward . . . Punt Loads 11,556.

Brought forward . . . . . Punt Loads 11,556

Secondly. By the propelling power No. 1, 2, 3, and 4, dredgers lifted.

	Quantity raised in 1838 by Manual Labour.	Increase.
	Punt Loads.	Punt Loads.	Punt Loads.
In 1842 . .	22,449	13,540	8,909
1843 . .	21,938	13,540	8,398
1844 . .	23,895	13,540	10,355
Total Increase by the Propelling Power .		27,662 Punt Loads.	. 27,662

Thirdly. In order to arrive at the performance of No. 5, it may be observed that she began to work in the end of May, 1841, and stopped the 25th December, being 30 weeks, during which period she raised 3438 punt loads, and was worked by manual labour.

In 1842, 1843, and 1844, she raised the following quantities in the following periods by the propelling power of machinery:—

Manual Labour.			Propelling Power.	
Punt Loads.	Weeks.		Punt Loads.	Weeks.
1841 3,438	30	1842	8,832	46
		1843	7,506	40
		1844	6,683	42
3,438	30		23,021	128

It appears that No. 5 in 1841 worked 30 weeks, and lifted by manual labour 3438 punt loads; and during the years 1842, 1843, and 1844, she worked 128 weeks, and would consequently, in the same ratio, have lifted by manual labour (30 : 3438 :: 128 = 14668) 14,668 punt loads; which, taken from 23,021 punt loads which she actually lifted by the propelling power in 128 weeks, leaves an increase of 8353 punt loads . . . 8,353

47,571

Fourthly. Quantities lifted by Nos. 1, 2, 3, 4, and 5 dredging-boats.

Manual Labour.

	Punt Loads.	Punt Loads.	Punt Loads.
In 1838 Four Boats lifted	13,540		
1839 ,, ,, ...		14,217	
1840 ,, ,, ...		19,516	
1841 Five Boats ,, ...		21,881	
			55,614

Steam Propelling Power.

1842 Five Boats lifted . . .		31,281	
1843 ,, ,, . . .		29,444	
1844 ,, ,, ...		30,578	
			91,303
Total			146,917

The above statement shows that *five boats* using the propelling power dredged up during each of the years 1842, 1843, and 1844 more than double the quantity that *four boats* dredged up in 1838 by manual labour.

	Punt Loads.
The first statement shows an increase by four dredges in 1839, 1840, and 1841, as compared to 1838 working by manual labour, of . . .	11,556
Second statement shows an increase by four dredges in 1842, 1843, and 1844, as compared to 1838, working by the propelling power of . .	27,662
Third statement shows that No. 5 had obtained an increase of 8353 punt loads working by the propelling power, as compared to the amount of her duty performed by manual labour of	8,353
Total increase . . .	47,571

47,571 punt loads of additional material has been dredged up from the bottom of the harbour of Glasgow and the river Clyde, in working the steam-dredges during the years 1839, 1840, 1841, 1842, 1843, and 1844, as compared to the performance of steam-dredges Nos. 1, 2, 3, and 4, in 1838.

The machinery fitted up and placed by Mr. Bald in the steam-dredges in 1842, to move them forward by the power of the engines instead of manual labour, is of the simplest kind, and not liable to derangement. There are four pair of mitre wheels, and three pair of spur wheels, for altering the different speeds. The power is applied by a 6-inch leather belt, wrought by a pulley attached to the fly-wheel, and works in a most effective manner.

Appendix. No. 5.

Extract from Mr. Bald's Papers, showing the Amount of the Performance of the Labouring Force, and time of the Five Steam Dredge Boats on the River Clyde, by Manual Labour, propelling forward, and also by Steam Power, propelling forward.

By Manual Labour, Working Forward.

	Dredge No. 1.		Dredge No. 2.		Dredge No. 3.		Dredge No. 4.		Dredge No. 5.	
	Weeks.	Punt Loads.	Weeks.	Punt Loads.	Weeks.	Punt Loads.	Weeks.	Punt Loads.	Weeks.	Punt Loads.
1838	28	2,268	34	3,075	30	2,746	38	5,451	..	..
1839	38	3,366	38	3,312	50	3,538	42	4,001	..	..
1840	28	2,433	44	5,069	46	6,169	46	5,845	..	..
1841	50	5,354	46	3,307	40	4,894	42	4,888	30	3,438
By Steam Power, Working Forward.										
1842	40	4,740	28	4,469	46	6,090	46	7,150	46	8,832
1843	38	4,957	44	4,965	40	4,768	44	7,248	40	7,506
1844	42	5,483	46	8,191	32	4,504	38	5,717	42	6,683

No. 6.

No. 6.

Total Amount of Excavation dredged from the bottom of River Clyde and Harbour of Glasgow in the following Years.

No. of Dredge Boat.	In 1838.	In 1839.	In 1840.	In 1841.	In 1842.	In 1843.	In 1844.
	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.
No. 1 .	2,268	3,366	2,433	5,354	4,740	4,957	5,483
2 .	3,075	3,312	5,069	3,307	4,469	4,965	8,191
3 .	2,746	3,538	6,169	4,894	6,090	4,768	4,504
4 .	5,451	4,001	5,845	4,888	7,150	7,248	5,717
	13,540	14,217	19,516	18,443	22,449	21,938	23,895
5 .	..	..	..	3,438	8,832	7,506	6,683
Totals .	13,540	14,217	19,516	21,881	31,281	29,444	30,578
Excavation in Upper Harbour, per Contract							1,188
Total quantity excavated 161,645 Punt Loads, from the beginning of 1838 to the end of 1844 A punt load is about 10 cubic yards, or 13 tons							31,766

No. 7.

No. 7.

Sir, *Rouen, 16th April*, 1845.

Being informed that you are the engineer for the River Clyde, and being desirous of getting some information from your country on a subject which we know to have met success with you, and which now greatly occupies our minds here, I beg leave to address you about it, and shall feel particularly obliged for any answer you will have the goodness to give me on the matter. I mean the improvement of rivers, the outfall of which is obstructed by moving sands, as it is the case with our large River Seine.

Not doubting but you may have at least some general knowledge of it, I scarcely need mention that on either side of the mouth there are two out harbours or ports; the one Havre, the other Honfleur. Their interval (about 10 or 12 miles) is greatly impeded by several shoals, some of shingle, some of sand, carried in by the flowing tides; some fixed, some moving, according to the strength of the ebbing tides, and of the winds. But, however injurious this may be, the there existing struggle between the said two opposite powers is considered as the origin of a very important propriety for the port of Havre, viz., to keep its high water about one hour and a-half after the tide is fully risen. It is also a prevailing opinion there that the very large space in the mouth of the river is necessary for receiving the sands or stones coming from sea long side of the coast, and that any alteration that could be made to that mouth might endanger the safety of Havre under both above points of view.

The said shoals extend nearly 30 miles upwards in the river, and the channel or stream of the inland waters will change their course at almost every spring tide, and be divided in many small channels,

either of which want sufficient depth, so that at neap tides, almost no vessels can pass, and at spring tides no larger vessels than 10 or 12 feet deep can get up.

The borders of the river will offer large expanses of area covered by the flowing tides.

It is a general belief that the said shoals, or accumulations of sand or silt, brought down also from the interior, by their making a kind of natural weir at sundry places across the river, and thus retarding the ebbing tides, greatly contribute to the preservation of a greater depth of water in the upper part of the river, and that in case of their being removed, a great alteration of its present level might take place upwards.

Now however we are going towards some trials for improvements of this river, that should consist in deepening it by contracting the banks to a reasonable width, and preventing the river to spread widely as it used to do, always allowing the free course of the tide, &c. But even these works, though limited at first to the upper part of the river, are opposed by many people as being capable of producing both the bad effects above alluded to, viz., to alter the course and rules of the waters below, so as to injure the good proprietary of the port of Havre, and at the same time to be not less obnoxious to the port of Rouen by diminishing the depth of its waters.

Of course such objections, if grounded, ought to deserve a great deal of attention; but while our most eminent engineers are divided of opinion amongst all their theoretical knowledge, we, but common people, should wish to know whether there be not in England some well known plans where works of the same kind, under nearly similar circumstances, might have been executed without bringing forth all the dreadful effects which are now prophetized to us. We have much heard of the Clyde, as having well succeeded; of the Mersey (but we do not know whether any thing was brought to a conclusion there, or whether it remained to a mere state of project); of the Ouse, of the Severn, &c.; but we know extremely little, with a sufficient accurary, of what may exist or not exist as for any analogy between those places, their conditions, the constitutions of their rivers and ours.

Please, therefore, to tell me (if you can do so without too much trouble) what may be your opinion upon the whole, and particularly at what places you should think that some such enterprizes having succeeded, might be consulted as a sort of guidance and authority in any actual discussion of ours.

Be so good as to excuse my intruding upon you, being totally unknown, and believe me, very respectfully,

Sir, your obedient, humble Servant,

J. RONDEAUX,
President of the Chamber of Commerce at Rouen.

Mr. Bald, Engineer for the River Clyde.

Glasgow, Office of the Engineer of the Clyde, March, 1845.

SIR,

I HAVE received your letter of the 12th instant, and do regret exceedingly that I have not been able to answer it sooner; but in reply I have only to say, that I shall be delighted to give you any advice or assistance in my power regarding the improvement of the navigation of the River Seine and Ports of Havre and Honfleur.

I have seen your river Seine, but it is 19 years ago, and I have not been in France since 1831; but, nevertheless, reading your letter carefully over, I can readily understand what your objects are.

All the celebrated engineers of this country,—Smeaton, Rennie, Telford, Nimmo, &c., have all concurred in opinion that the improvement of tidal rivers for navigable purposes depends upon obtaining a greater flow and a greater quantity of tidal water upwards into them. Now, this principle being admitted, it is manifest that all obstructions to the tidal flow upwards should be removed, such as shoals, bars, &c.; and that all means should be adopted to increase the quantity of tidal water into all the higher and upper reaches of tidal rivers. This will give a greater scouring power to keep the navigable channel free from shoals; but it may also considerably deepen and improve it. Besides, if there are any bars or shoals at the mouth of a tidal river, their removal can best be achieved by obtaining and procuring a larger quantity of additional tidal water up into the higher reaches of the river.

Now, you state that it is proposed to deepen the river Seine by contracting its banks, and to prevent the water of the river from spreading so widely as it used to do; and that this operation is to be limited at first to the upper part of the river, always allowing the free course of the tide, &c.

I really do not see how you can contract the banks of any river so as to prevent the water spreading, without in some measure intercepting the tidal flow. I should be wanting in duty if I did not warn you, on no account to give the least obstruction to the tidal waters upwards by narrowing the banks of the river, or by the construction of dykes. To achieve this important object requires much careful consideration and great reflection in the construction of the works; because, if you shall in any measure diminish the tidal flow upwards into the highest recesses of the Seine, you will lessen your tidal scour outwards, and in all likelihood diminish the depth of water at the mouth of your river, and also at your ports of Havre and Honfleur. My advice is, to try and carry the tidal waters as high up as possible into the upper recesses of the Seine, and to be cautious and careful how you narrow the river. I am not able to convey to you all my ideas regarding this great and important improvement for France; because I am not in possession of many details connected with the speed and volumes of the fresh and salt water ascending and descending, the nature of the bottom, soil, tides, &c. &c.; nor am I in possession of any detailed plans to enable me to arrive at anything definite on this interesting subject: but, nevertheless, I am strongly impressed with the idea, from my recollection of the Seine, that a great improvement could be effected as regards its navigation.

I am not able to refer you to any river in Europe where so much has been done as in the Clyde in improving a tidal river navigation; in 1755 the River Clyde could only float vessels drawing three feet six inches of water; now the River Clyde can float vessels drawing eighteen feet of water, notwithstanding the many errors which have been committed in improving it during the ninety years it has been under the hands of the engineer. And I really do not see why you should not, with care and attention in the construction of works, attain a depth of 20 feet of water instead of 10 or 12 feet, as you mention; and that fleets of both merchantmen and also of men of war should be able to obtain perfect shelter and security within the embouchure of the River Seine.

I shall be very glad to hear from you, and it is very likely that I shall be shortly in London, and also perhaps in France, and should be very glad to examine your projects of improvement in passing on my way from Havre to Paris, and render you every service in my power, and give you all my ideas when I shall see the plans and charts of the River Seine. I again take the liberty to caution you that

Appendix. No. 7.

any works which shall be proposed for the deepening of the navigation of the Seine should be carefully considered, because a great deal has been done on this River Clyde which must be undone at a great expense; errors of the gravest kind have been committed, notwithstanding the great success in deepening it, and this depth is now only preserved by an annual dredging of about 180,000 *cubic yards* of deposit on a river line of 18 miles long. Now the great object should be to get the tidal scour, to preserve the depth, and save this great annual expenditure; therefore the operations of nature should everywhere be assisted in deepening by the aid of works which have been found to be successful.

I am Sir, with great respect,
Your obedient Servant,

à Monsieur J. Rondeaux, President of the Chamber of Commerce at Rouen. (Signed) William Bald.

No. 8.

No. 8.

Extract from the Appendix of Mr. Bald's Report on Blackstone Moss; addressed to the Clyde Trustees, 23rd September, 1844.

The great and expensive works which have been erected to obtain a back scour of water may be fully appreciated by referring to the artificial reservoirs of water with sluicing gates attached to many of the continental harbours, prove the great benefit which have been derived from the power of water in deepening harbours by back scouring water, and also in afterwards preserving and maintaining the depths obtained.

Indeed the artificial scour through harbours from back water by reservoirs and sluice-gates perform the work of the modern steam dredgers. Those reservoirs and sluice-gates are to be seen at the ports of Nord Catwyck, in Holland; also at Ostend and Dunkirk, in France. The latter harbour was formed by purely artificial means, viz., scouring reservoirs of back water and sluices, and was one of the most successful harbours which the engineers of France had constructed, although the whole of the coast adjacent to the harbour was flooded with immense banks of moving sand, yet by the industry of the engineer it became in time of war one of the most formidable ports upon the whole coast of France to the commerce of England. In 1706 it enjoyed a most flourishing trade, and during the war, which terminated in the Peace of Utrecht, its privateers took 1614 English ships, value 1,334,375*l.* England suffered so much that she would consent to no peace unless the whole harbour and fortifications were destroyed, and the harbour filled up at the expense of France. This clause was inserted in one of the Articles of the Treaty of Utrecht, which was signed on the 28th April, 1713. This was done under the direction of Colonels Armstrong and Clayton. Yet after this Louis XIV. constructed a new canal to Mardyke, by which the harbour was much improved. In 1717 France was again compelled, by a treaty at the Hague, to destroy the harbour. In 1748, by the treaty of Aix-la-Chapelle, Dunkirk harbour was again doomed to be destroyed.

Extract from Mr. Bald's Report, read before the General Meeting of the Clyde Trustees, on Tuesday the 3rd September, 1844.

The improvement of the navigation of the Clyde and the harbour of Glasgow by deepening is principally due to the labouring force of the steam dredgers, and which is attended with a very considerable annual expense. A question has arisen, whether it might not be possible to work them a longer period of time each day, and perform a greater quantity of work.

In order to throw some light on this very interesting subject as regards expenditure, the preservation of the depth of the present navigation and its further improvement, it may be first observed that there are five steam dredgers employed in the deepening operations of the harbour and river; their power and depth of working are as follows:—

No. 1	steam dredge	has an engine	12	horse power	which works in	12	feet depth of water.
No. 2	ditto	ditto	16	ditto	ditto	14	ditto.
No. 3	ditto	ditto	16	ditto	ditto	14	ditto.
No. 4	ditto	ditto	20	ditto	ditto	15½	ditto.
No. 5	ditto	ditto	22	ditto	ditto	17 to 19	feet ditto.

Looking at the small depth of water which these steam dredgers work in, with the exception of two of them, and again at the depth in the ship channel of the river Clyde and harbour of Glasgow at high water; and which frequently extends from 15 to 20 feet in depth at lofty tides in gales blowing from south and south west, it must therefore be manifest that there is a very large portion of time each day in which none of these steam dredgers can work, their bucket frames not being able to reach the bottom, and it must be further observed that both the harbour of Glasgow and the river channel of the Clyde are becoming deeper, and consequently lessening the time of working these dredgers.

It has been often asked why do not these steam dredgers work continuously? From what has been stated it must be admitted that this is impossible, and to attain so desirable an object would require steam dredgers capable of working in all depths of water in the harbour and river. There can be no doubt but iron steam dredgers of 30 to 40 horse power, capable of working in depths of more than 20 to 22 feet of water, and each dredger lifting daily more than 100 punt loads, would be much more economical than working the present dredgers, both in the great additional quantity which would be lifted, men employed, fuel consumed, &c., &c. And there would be great facilities to clean out the harbour of Glasgow rapidly. Three such dredgers might lift out of the harbour in 25 good working days (Summer time) 75,000 cubic yards; this would be an object of very great importance, because it is only at certain periods when the harbour is not crowded with vessels that it can be cleaned; and it is for many more reasons desirable that this work should be done very quickly.

I presume that it is now manifest that to achieve continuous working would require a complete change in the greater part of the whole of the trustees' dredgers.

Looking at these facts, and the present limited working power of these dredgers, I am not aware that much more can be done unless the trustees shall construct two additional iron dredgers, &c., with engines of 30 to 40 horse power each, and capable of working freely in 20 to 22 feet depth of water, as already mentioned, and to sell dredging machines Nos. 1 and 2. This I should strongly recommend, as it would be much more economical than working these old machines, by which so much valuable time and men's labour are lost. This very subject was again brought before the trustees in one of the monthly reports read before them last winter.

Extract of a Letter addressed by Mr. Bald to Mr. David Hope, Chairman of the Committee of Finance, dated London, Trafalgar Hotel, Charing Cross, 5th May, 1840.

I hold it as a principle in all public works, that the clerk who keeps an account of the men's time, should never, on any account, be the individual who pays them. Secondly, that no person connected with the engineer, as foreman or overseer, engaged with the execution of the works, should ever be entrusted with money to pay the workmen and labourers under them; this important duty should be only performed by an individual totally unconnected with all the parties engaged in the executive departments of the works. The foreman of the works, and the clerk who keeps the men's time, should be present when the pay-clerk pays the accounts, and they should witness the payments, and attest the respective pay sheets, by their signature, paid in their presence by the pay-clerk on such a day. This is the principle adopted by the Government in all the public works in Ireland; nor will the Commissioners of Imprest Accounts pass the disbursements of public money, laid out in the execution of public works, upon any other principle.

Engineers' clerks for keeping the workmen's and labourers' time, engineers' foremen, and overseers and engineers themselves, should never have anything whatsoever to do with money, or its payment in any shape or manner.

These are my ideas frankly expressed, and which I before verbally communicated to you.

I am, dear Sir,
Your very faithful servant,
WILLIAM BALD.

A copy of the above letter was sent to the present chairman of the Clyde Trust more than one year ago, but no notice was taken of it, until some irregularities were discovered in making the payments (and which I believe have not yet been adjusted) when the principle of the above letter was obliged to be acted upon, and a total change made in paying the workmen and labourers, but not until after a period of nearly four years had passed.

No. 9.

Bowling Basin.

This basin is situated on the north side of the River Clyde, about 10 miles below the harbour of Glasgow; it encloses a water space of about 14 acres. At the extremity of its western arm a timber wharf has been constructed, about 300 feet in length, alongside of which the largest Indiaman can lie. This basin was commenced in 1841; no plans were ordered to be made of it, nor were any designs laid before the trustees for its execution; a small model was made of the timber work by the late Mr. Robert Bald, and the whole works were completed in one season, so that the large American ships with others were laid up in it during the winter. This basin has given, since its construction, great accommodation to vessels, when the harbour of Glasgow has been crowded. In January, 1844, there were lying in Bowling Basin, 10 square-rigged vessels, 14 steamers, and a great number of other kinds of craft, amounting in the whole to 53; and besides, it has been most useful in affording accommodation to the whole of the Clyde Trustees' dredging vessels diving-bells, punts, &c., &c., and is a most valuable appendage to the port of the city of Glasgow. This work was executed under my direction, without any remit from the trustees; and the zeal and attention of the late chairman, James Hutchison, Esq., to this work during its execution was above all praise, he visited the works once and twice in the week during the fine weather; and indeed bestowed, during the time he was chairman, a very great portion of his time to all the improvements of the river, and frequently went down the Clyde for that purpose.

No. 10.

STEAM DREDGERS.

Extract from Mr. Bald's Details of the Working Operations on the River Clyde.

Number of Boat.	Depth of Working.	Least Depth of Working	Diameter of Cylinder.	Length of Stroke.	Number of Buckets on Frame.	Strokes per Minute.	Length of Frames.	Nominal Power of Engine.
No.	Feet. In.	Feet. In.	Inches.	Feet. In			Feet. In.	
1	10 6	3 9	21	2 6	31	38	47 9	12 H. P.
2	14 0	4 0	24	2 6	33	38	52 11	16 H. P.
3	14 0	4 0	24	2 6	33	38	52 11	16 H. P.
4	15 6	4 3	26	2 6	34	38	54 7½	20 H. P.
5	17 to 19	4 4	27½	2 6	34	38	58 0	22 H. P.

APPENDIX.

No. 10.

Steam-tug, two engines each 30-horse power; diam. of cylinder 30 inches; length of stroke 3 feet 9 inches; strokes per minute 40.

All the steam-dredgers have governors which regulates the speed to about 28 strokes per minute in ordinary working stuff.

Average pressure in boilers about 3½lbs to the square inch.

In general 14 buckets are discharged per minute.

The speed of the buckets on the frames in Nos. 1, 2, 3, and 4, is (3 ft. 5½ in. × 14=48 ft. 5 in.) 48 feet 5 inches per minute

And No. 5 is (3 ft. 8 in. × 14 = 49 ft. 8 in.) 49 feet 8 inches per minute.

The larger the engine, the less is the consumption of fuel on board of the dredgers. The small engines are worked to their full power, and consequently consume more fuel in proportion to their power than the larger engines, which are not so much pressed; for example, No. 1 consumes about 18 lbs. of coal per horse-power per hour; while No. 5 only consumes 15½ lbs. per horse-power per hour.

Extracted from Mr. BALD's Details of the WORKING OPERATIONS of DEEPENING and CLEANSING the RIVER CLYDE and the HARBOUR of GLASGOW.

	Amount Expended.			Quantity of Work Executed.	Rate per Cubic Yard.		
	£.	*s.*	*d.*	Cubic Yards.	£.	*s.*	*d.*
Year ending 25th December, 1841 . .	11,841	18	2	218,810	0	1	1
Year ending 24th December, 1842 . .	13,612	11	3	313,810	0	0	10½
Year ending 23rd December, 1843 . .	9,742	7	6½	294,440	0	0	8
Year ending 21st December, 1844 . .	10,659	3	8	317,660	0	0	8

The expense of dredging and depositing the material taken up from the bed of the river Clyde and the harbour of Glasgow varies considerably, on account of the nature of the material in the bottom, and the distance it has to be carried for deposition.

A punt load may be taken at an average at about 10 cubic yards, or 13 tons.

VALUE OF MACHINERY EMPLOYED ON THE RIVER CLYDE.

	£.	*s.*	*d.*
5 deepening machines with engines and gearing . .	20,000	0	0
Steam-tug, with two engines each 30-horse power .	3,300	0	0
157 punts	12,560	0	0
13 punts for stones	650	0	0
2 diving-bells	750	0	0
Fifteen additional iron punts amount to about . . .	2,025	0	0
Total.	£39,285	0	0

Note attached by Mr. Bald to the Clyde Bank Monthly Accounts of the 9th November, 1844.

As the Clyde Bank accounts were usually before this period, checked in Mr. Spreull's office before being sent into the Engineer's office; Mr. Bald requests the attention of the Committee of Finance to the rate of wages for labourers charged in the Clyde Bank accounts, which is at the rate of two shillings and twopence per day, while the rate of wages paid to the labourers both in the harbour and river is one shilling and tenpence per day. Mr. Bald cannot see on what grounds this anomaly should exist in the Clyde Bank department as regards the pay to the labourers, and which is two shillings per week more than what is paid to the labourers employed on the works of the harbour and river.

Mr. Bald has to state that not the least notice was taken of the above note, nor any rectification made by the Committee of Finance, as to this anomaly in the payment made to the labourers at Clyde Bank.

No. 11.

No. 11.

[Clauses respecting the Glasgow Water-works, referred to in Q. 2365.]

Extract from the Act 6 *Geo. IV., cap.* 117.

Sec. 6. And be it further enacted, That the said trustees shall be, and they are hereby authorized and empowered by themselves, their deputies, agents, workmen, servants, and assigns, to commence, carry on, complete, and maintain such of the works and operations aforesaid, and such other works and operations as may be found expedient, for deepening the bed or channel of the river, upwards from the said harbour of Glasgow, to the south-east extremity of the public green of Glasgow, belonging to the corporation of the said city; and also to excavate and construct, out of and upon the bed or channel, or banks of the said river above, or to the east of the said bridge at the Broomielaw, and under the said bridge such a deepened navigable channel, cut, or canal, and tunnel, and below, or to the west of the said bridge, such canals, locks, tide-docks, and other similar works, as may be found requisite for opening and maintaining a communication, and safe and easy navigation for vessels loaded with coals or other commodities, passing from the higher parts of the said river to the said harbour at the Broomielaw.

Sec. 7. Provided always, and be it further enacted, That the said trustees shall not, by any operations hereby authorized, injure or endanger any of the said bridges over the said river at Glasgow; and the said trustees shall be and they are hereby bound and obliged, from the rates and duties hereby granted for deepening the said river above the Broomielaw, to indemnify the magistrates and council of the said city, as trustees under the Acts for erecting and repairing the said bridges; and all others having a legal interest therein, against all or any damage or injury that may be sustained by the said bridges as aforesaid, and also to indemnify the Company of Proprietors of the Glasgow and Cranston Hill Water-works, and the Glasgow Gas-light Company, out of the said funds, for any costs or charges arising in the repairing any damages to be done to the water or gas-pipes of the said Companies carried along the said bridges: Provided also, That the whole of the said operations on, or in the vicinity of the said bridges, shall be performed at the sight, and to the satisfaction of two engineers, one to be named by the said trustees for the bridges, and the other by the said Company of Proprietors of the Glasgow Water-works, and in the event of their differing in opinion, by a third engineer, to be named by these engineers, who, in a report to be made in that behalf, shall state the works to be performed, and how they are to be performed, before the same shall be executed.

Sec. 8. Provided always, and be it enacted, That any lock to be constructed for the purpose of connecting the lower with the upper navigation, shall be placed below the new bridge, and below the weir now in the river, so that the level of the top of the gates of such lock shall not be higher than the present level of the top of such weir, and the masonry of the said lock shall not be higher than the surface of the ground under the south arch, and that the whole shall not present any greater hindrance or obstruction to the passage of the flood-water than is now presented by such weir.

Sec. 9. Provided always, That the works hereby authorized to be carried on above the harbour of the Broomielaw, shall be conducted on such a plan, as neither to raise nor lower the surface of the River Clyde at low water above the new bridge of Glasgow: And provided further, That that part of the river which is situated between the wooden bridge, opposite to Saltmarket-street, and the south-east extremity of the green of Glasgow shall be deepened for the purposes of this Act, by scouring and dredging the channel thereof only.

Sec. 12. Provided always, and be it enacted, That none of the powers or authorities hereby granted, for, or in relation to the improvement of the navigation of the said river above the Broomielaw, shall be put in execution unless, and until the said trustees or others duly authorized shall, at the sight, and to the satisfaction of, and in conformity to a specification to be previously furnished by two engineers, one to be named by the said trustees, and the other, by the Company of Proprietors after mentioned; and in the event of the latter failing to do so within 30 days after a requisition upon them to that effect made then by the said trustees, have made and executed such works, as in the opinion of the said engineers (or, in case of their differing in opinion, of a third engineer to be appointed by these engineers,) shall be fully sufficient and effectual to preserve the bed or channel of the said river at Dalmarnock Bridge at its present height or level, nor until the sheriff depute of the county of Lanark shall be satisfied that sufficient means shall have been provided for the due preservation and repair in all time thereafter, of the works necessary for that purpose, so that no damage or injury from the execution of the said operations shall arise to the works of the Glasgow Water-works Company, incorporated by an Act passed in the reign of his late Majesty, intituled "An Act for supplying the city and suburbs of Glasgow with water."

Sec. 13. And be it further enacted, That in carrying into effect the provisions contained in this Act, in so far as regards the deepening of the said river above the harbour of Broomielaw, the rates and duties leviable for deepening that part of the said river above the said harbour shall be liable for any injury or damage which may be thereby occasioned to the said Water Company.

Extract from the Act 3 *and* 4 *Vict., cap.* 118.

Sec. 28. And be it enacted, That for the protection of the Company of Proprietors of the Glasgow Water-works, the said trustees shall be bound and obliged, and they are hereby required and authorized to support and maintain at its present height the dam or weir across the said river above the harbours of Broomielaw, and below Glasgow Bridge, until the said trustees shall have strengthened the weir, or the bed or channel of the said river at the old or Stockwell-street Bridge, in such manner as shall be sufficient to maintain the top water or head level of the said river at low water, at the height at which it is at present maintained above the said old or Stockwell-street Bridge, or until such other works shall be constructed below the water-works of the said Company of Proprietors as shall be sufficient to maintain the said top water or head level at the height at low water, at which it is at present maintained above the place where such other works may be constructed; which operations for strengthening the weir or bed, or channel of the river at the said old or Stockwell-street Bridge, or such other works as aforesaid shall be executed and maintained by the said trustees at the sight of two engineers, one of whom shall be nominated by the said trustees, and the other by the said Company of Proprietors; and the said two engineers shall have power, in case of any difference of opinion, to appoint a third engineer, to determine the point or points in dispute between them: Provided always, That nothing herein contained shall be held or constructed to interfere with or prejudice the rights of any parties which are now the subject of litigation in any suit or suits at present depending before any Court of Law, as such rights shall be ascertained and determined in such pending suits.

Sec. 29. Provided always, and be it enacted, That if any loss or damage shall arise to the said Company of Proprietors of the Glasgow Water-works by, through, or in consequence of the failure of the said trustees to fulfil the provisions herein contained for the protection of the said Company of Proprietors, or by, through, or in consequence of the insufficiency of the operations, or works to be executed by the said trustees for that purpose, or by, through, or in consequence of any operations executed under authority of this Act, then and as often as such loss or damage shall arise, the said trustees shall be bound and obliged, and they are hereby required and authorized to compensate the said Company of Proprietors for such loss or damage out of the funds and revenues of said trust: Provided always, That the said trustees shall not be liable for any loss or damage which may arise by, through, or in consequence of the exercise of any rights of any parties which are now the subject of litigation in any suit or suits at present depending in any Court of Law, as such rights shall be ascertained and determined in such suit or suits.

Sec. 30. And be it enacted, for the protection of Messrs. Henry Monteith and Company, and of Messrs. John Bartholomew and Company, as owners of certain dyeing and printing works situate on the banks of the said river of Clyde, at Barrowfield and Dalmarnock, and their successors in the said

APPENDIX. No. 11.

works, that if any loss or damage should arise to the said Henry Monteith and Company, or to the said John Bartholomew and Company, or theirs aforesaid by, through, or in consequence of the removal or lowering the said dam or weir above the harbour of Broomielaw, and below Glasgow Bridge, or the execution of any work or operation hereby authorized, or in case the said trustees shall not effectually prevent such loss or damage by the execution of works for that purpose, then and as often as any such loss or damage shall arise, the said trustees shall be bound and obliged, and they are hereby required and authorized to compensate the party or parties sustaining such loss or damage, for such loss or damage out of the funds and revenues of the said trust: Provided always, That the said trustees shall not be liable for any loss or damage which may arise by, through, or in consequence of the exercise of any rights of any parties which are now the subject of litigation in any suit or suits at present depending in any Court of Law, as such rights shall be ascertained and determined in such suit or suits.

No. 12.

No. 12.

Report on the Tay Navigation, from the Admiralty Surveyor on the East Coast of England to the Hydrographer to the Admiralty.

Her Majesty's Ship Blazer, Queen's Road, Dundee, 1st October, 1844.

SIR,

Plan of the Tay.

HEREWITH I have the honour to forward a corrected plan of the river Tay, showing the changes that have taken place in the Gaa sand at the mouth of the river between the date of Captain Slater's survey in 1833, and our examinations just completed in September, 1844.

Taking advantage of the leisure time afforded while lying with the Royal Squadron in attendance upon Her Majesty, in the Queen's Road, at Dundee, and in accordance with your special instructions on this point, the banks at the mouth of this river have been thoroughly sounded over and examined; the results are all, I am happy to say, favourable, so much so that the shoal hitherto termed "Tay Bar" no longer exists, and vessels drawing 24 feet water may now enter the river, and bring up in safety within its shelter at the lowest water of spring tides.

Decrease of Gaa sand.

On comparing the two surveys, it appears that the spit of the Gaa sand, within the two fathoms' edge, which formerly extended from its extreme dry point off Buddon Ness, in about a S.S.E. direction, in a compact body, ($1\frac{1}{2}$ miles in length by $\frac{1}{2}$ a mile in breadth,) has now turned outwards to nearly an E.S.E. direction; has moved bodily $\frac{1}{2}$ a mile to the eastward, and is broken up into small patches, with deep water between, so that in spots where in 1833 were only 3 and 7 feet, we have found 16 and 20 feet water. One detached ridge of 12 feet water still remains to the southward of the spit, but from its extreme narrowness, being only half a cable wide, and its crescent-like form, I should imagine the first winter freshes, joined to a spring ebb, will disperse it like the rest.*

Slight increase of Abertay.

While these great changes (in which a mass of sand of not less than six millions of cubic yards has been removed) have been going on on the eastern side, the spit of the Abertay on the western side has grown out a little to the eastward (the natural consequence of being relieved from the pressure of the pent-up tide), but not at all so as to interfere with the entrance, which at the narrowest part is 800 yards wide between the 3 fathom edges. The general depth in mid-channel is also much increased, on an average about 10 feet, so that, as before stated, a vessel drawing 24 feet water, by bringing the Gaa buoy to bear W.N.W., may boldly run into shelter at the lowest spring tides.

Entrance well buoyed.

The edge of the Abertay sand is now well marked by three red buoys, to be left to 'Port' on entering, and the Gaa spit by two chequered black and white buoys, to be left to starboard, the passage lying between them, with the two Buddon Ness lights in one, which lead directly past the black Fairway buoy. By day, also, Lord Panmure's monument, recently erected on the summit of Camus Stone Law, kept a little open to the eastward of the remarkable red Gaa sand-hill, will lead up to the entrance.

Within, the channel of the river does not seem to have much altered, if anything it is deeper; a black buoy has been lately placed on the Horse-shoe shoal, near Broughty Castle; and the Newcome spit, just off the Craig Lights, still projects from the south shore, nearly half across the river.

Drummond Rock.

Off the town of Dundee we found a rock, named Drummond Rock, not placed in any plan of the river, with only 4 feet on it, marked by a floating beacon; and close in to the westward are rocks called the Gryces, also marked by a floating black spar. The position of the Drummond Rock, just at the entrance of the basin, is so dangerous, that if it be allowed to remain, which I can hardly imagine, it should be marked by a fixed beacon, like the "Fowler" and "Beacon" rocks, in its immediate vicinity. A little to the westward of the town, the "Ballast Bank," lying between Magdalen-yard Point and the Craig rock, has turned out a little, and come lower down the river—a point that requires great attention; the 'Middle bank,' however, has not increased.

Queen's Road.

The roadstead in which the Queen's yacht and the royal squadron are anchored lies between these two banks, in 20 feet at low-water springs. It is perfectly sheltered and secure, and the bottom affords good holding ground. As this roadstead has no name on the Admiralty plan of the river, we have ventured to call it Queen's Road, in remembrance of Her Majesty's auspicious visit to this part of Scotland.

Improvement in Dundee.

The alterations and improvements in the sea-face of the town of Dundee, since the date of Captain Slater's survey in 1833 are great; but compared with its state within the memory of man, "when its harbour was a crooked wall, enclosing but a few fishing or smuggling craft," they almost exceed belief. Two spacious wet-docks, containing an area of $11\frac{1}{2}$ acres, are already completed, and in full activity; another wet-dock, of more than double the extent, is laid out; with two tidal harbours, one of 5 acres, now in use, the other of 11 acres: besides graving docks, patent slips, and every requisite for a first-class commercial port. The good result of such enterprize and energy, directed by a skilful engineer, is shown by the more than doubled revenue of the port, and the increase in the number of the shipping that frequent it:—

	£.
In June, 1833, the total revenue was . . .	10,291
In June, 1844, ,, . . .	23,895

While the number of shipping had increased to 3791, having a burthen of 272,239 tons.

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* The only other plans of the river which I have seen are one by the Messrs. Stevenson, engineers, made in 1816, and that of Greenvile Collins, (who by direction of Charles II., surveyed these coasts in 1680,) published in his "Coasting Pilot." The plan purporting to be by Adair, said to have been published in 1690, is a fac-simile of that of Greenvile Collins.

Hitherto all has been prosperous, and probably will be so for years to come; but it is not difficult to foresee that, unless some decisive steps are taken to prevent it, the face of the quays and the entrance to the tidal basins will silt up. Already a dredging-machine is in constant employment. The Fowler, Beacon, and Drummond rocks, just to the eastward of the entrance, in addition to the impediment they offer to navigation by causing a slack on the flood tide, are occasioning a deposit, and a slight concavity in the face of the sea-wall tends to lead the silt into the basin; at the same time the Ballast Bank is gradually extending to the eastward, and widening. The most obvious mode of arresting these evils would seem to be by blasting the rocks entirely away, and by running a sea-wall from Magdalen-yard Point, in a slightly curving direction, to the Craig Rock, in order to guide the ebb stream in its strength along the face of the quay. This plan has, I believe, been proposed by Mr. James Leslie, the very able resident engineer; and although there may be some conflicting interests to contend with, everything should give way to the careful preservation of the port, and I trust he may be allowed to carry out his plans.

Rocks should be blasted away.

Continuing higher up the river, as far as Newburgh, the only perceptible changes that have taken place are, I regret to say, caused by embankments and dykes along the north shore. One of these extends into the river upwards of 1000 yards beyond high water mark; and were a curved line drawn, connecting the outer ends of these dykes, and continued as far as Monorgan Point, which would be the natural shape of the deposit caused by them, it would enclose a space of nearly 2000 acres, or 3 square miles. Now, when it is considered that the whole estuary between Dundee and the mouth of the Earn does not reach 18,000 acres, or 28 square miles, (16 of which are dry at low water,) it will be manifest that the space embanked is equal to nearly one-ninth part of whole estuary; and as the outer ends of some of these dykes have from 10 to 12 feet over them at high tides, it is evident that a large body of tidal water will eventually be excluded, and its scouring power lost, which must have a decided influence upon the banks in the lower part of the river, and opposite the town of Dundee. This is a great evil, and should be jealousy watched, as it is the scouring power of the tidal waters ebbing and flowing twice in the 24 hours that is the great agent in preserving our harbours from silting up.

Embankments.

Area of Estuary.

From Newburgh upwards, towards Perth, the changes in the river since the date of Captain Slater's survey have been great and beneficial. Between the years 1835 and 1842 the principal fords, some shoals, and many detached boulder-stones of large size have been removed, and the river along its whole course, between Perth and Newburgh, has been deepened. Three small islands, namely Sleepless, Darry, and Balhepburn, have been connected with the main land by sea-walls, so as to confine the whole of the water in the navigable channel, and render the scour more effective. The banks of the river, where contracted, have been widened so as to admit of the free and equal passage of the water, and a tide harbour has been formed at Perth. In the course of these works not less than 840,000 tons of soil have been dredged up, and the sum of 53,000*l.* has been laid out in improvements, independently of indemnification to the proprietors of the fisheries to the extent of 6000*l.* The advantages arising from these energetic works, carried on under the direction of the well-known skilful engineers, Messrs. Stevenson, of Edinburgh, have been many; by affording a free passage to the tidal waters, the flood tide now begins to flow at Perth three-quarters of an hour earlier, and has a range of 13 feet at the bridge at ordinary springs; a depth of from 4 to 5 feet is said to be maintained in the channels at low water springs, and the general navigation so improved, that at spring-tides vessels drawing 14 feet water can come up to Perth in one tide with ease and safety.

River Improvements.

The natural consequence of this has been, that the number of vessels that resort to this port has much increased; the arrivals and sailings in the past year, amounting to 944, of 45,325 tons' burthen, in addition to daily steamers between Dundee, Newburgh, and Perth; the harbour and customs dues have increased in equal proportions, the latter from about 3000*l.*, in 1830, have risen to an average of 16,837*l.* per annum, while in one year they were as high as 25,767*l.*

Increased trade.

So far good; but the Tay is susceptible of much further improvement. This magnificent river drains a surface of about 2300 square miles, or nearly double that of any river in Scotland; its length from the source of its most distant tributary is near 180 miles, while the variety in the relative distances of its sources furnishes an abundant and equable supply of water without the great floods that the Spey and Dee, and other mountain rivers, are so subject to. These are capabilities that a skilful engineer would readily turn to account; and I sincerely trust the Perth Trustees will go on with the work they have so well begun. Little else is wanting than to remove all obstructions in the bed of the river, and carefully to narrow the channel within certain limits in its upper part, gradually widening as it descends, at the same time dredging and deepening, so as not only to preserve the present, but to increase the sectional area of the channel, thereby affording full and free space for the tidal waters to ascend up to the bridge at Perth, and as much beyond as the natural obstructions in the bed of the river will permit.

Basin of the Tay.

The value of such free action to the tidal waters is not confined alone to the upper channel, but improves the river throughout. In the former part of this Report I pointed out the great change in the Gaa sand at the mouth of the river, and that six millions of cubic yards of sand had been dispersed since the year 1833, the date of the last survey.

Value of tidal waters.

Now, from every inquiry I have made I do not find that any remarkable freshes in the river have occurred during the last 11 years; but we know that a deepening of the bed of the river in its upper part has been gradually going on since the year 1835, by which a depth of 4 feet has been gained in several places, and the tidal water brought up to Perth three-quarters of an hour earlier. In the course of this dredging we have seen that upwards of 800,000 tons of soil have been removed, and although it is not easy to make an estimate of the consequent increase of reservoir, it is fair to assume that at least an equal number of tons of water (or say in round numbers a million of cubic yards) have been admitted on every tide.

And when we consider the additional scouring power gained by this increased volume of water passing to and fro twice a day, or 704 times in a year, it seems a fair inference, in the absence of any other known cause, that this has been the chief instrument in the improvement in question.

If, then, we may assume that the dredging which has already taken place between Perth and Newburgh has proved so beneficial to the Tay Bar at a distance of 25 miles, who can say that skilful engineering along its whole length might not eventually raise this river to the high rank of a Harbour of Refuge, and render the channel into the Frith of Tay as free as the present entrance into the Frith of Forth.

I am, &c.

JOHN WASHINGTON, *Captain.*

P.S.—I have great pleasure in bearing testimony to the ready attention and assistance I have met with from Mr. James Leslie, Resident Engineer, Lieut. Smart, R.N., Harbour Master, and Mr. Kennedy, Master of the Pilots, throughout our survey and inquiries.

Appendix.

No. 13.

No. 13.

Reports by the Engineer of the Dundee Harbour, regarding the Operations of Lord Kinnaird and Colonel Paterson, on the bed of the River Tay; referred to in the Report of James Walker, Esquire.

Gentlemen, *Dundee, 22nd September*, 1843.

I feel it my duty to call your attention to the fact, that a long dyke is now being built on the north shore of the river Tay, opposite the march between the properties of Lord Kinnaird and of Colonel Paterson of Castle Huntly.

This dyke extends outwards from high-water line, across the north banks of the river, with a view, I presume, to promote the silting up of the shore, and thereby to allow, in time, of a portion of ground being embanked from the tide and rendered arable, in the way that has been done by other proprietors on the north side of the river between that place and the mouth of the Earn.

I do not know what is to be the length of the dyke, as the advertisement for tenders, of which a copy is annexed, is expressed in very general terms; but I have reason to believe that it was at one time contemplated to extend it above two-thirds of a mile out from high-water mark, and that even more than double that length had been spoken of, which would have carried it considerably more than half way across the river.

Any encroachment on a tidal river or estuary, by lessening the quantity of its back-water, must diminish the strength of the scour at the lower parts of the river, and must thereby tend to form banks there, and so to injure the navigation; and, therefore, it is of the utmost importance to the interests of the Harbour of Dundee, that the estuary of the Tay should not be encroached on, or its capacity diminished by forming embankments, or by using any other artificial means to promote the silting up of its shores. It may be a question, whether any of the embankments, or other works, that have been already executed, or are now in progress, be of sufficient magnitude or importance to render any interference with them expedient or advisable; but it does seem indispensable that some inquiry should be instituted; for it is very evident that one encroachment leads to others, and that, if they were allowed to go on, without being objected to, they would soon increase to such an extent as to be attended with very injurious consequences.

The magistrates of Perth, or the Navigation Commissioners, if they do not encourage, seem at all events to take no means to prevent encroachment on the *north* shore—their object being, it would appear, to confine the navigable channel, as much as possible, to the *south* shore; and with that view they lately brought an action, and got a verdict of a jury, for the removal of several dykes or jetties on the property of the Earl of Zetland, between Flisk and Newburgh.

Now, the narrowing of the river may be of advantage to the navigation between Perth and Dundee, and more especially between Perth and Newburgh, but it is decidedly injurious to the navigation at and below Dundee; and the long dykes extending outwards from the north shore are especially hurtful to Dundee, by throwing the strength of the current over to the south side of the river, to which there is already too great a tendency without its being increased by artificial means.

I have the honour to be,
Gentlemen,
Your most obedient servant,
To the Trustees of the Harbour of Dundee. James Leslie.

(*Advertisement referred to.*)

Contractors wanted.

To build a sea wall at Polgavie; apply to James M'Laren, at Castlehill, betwixt this and the 24th current.

Castlehill, May 10th, 1843.

(From *Advertiser* of 12th and 19th May.)

Gentlemen, *Dundee, 16th October*, 1843.

Agreeably to the instructions given in your minute of the 4th instant, I last week, accompanied by Mr. Milne, visited and examined the dyke now being built on the north shore of the Tay, opposite the march between the properties of Lord Kinnaird and Colonel Paterson of Castle Huntly.

I measured and took the bearings of the dyke, and have laid it down on the accompanying plan.

The foundation is laid to the extent of 3110 feet, or four-sevenths of a mile, out from high-water mark, and in a direction bearing S. by E., by compass. The building is completed to the length of 410 feet; at which distance the top, which is about level with high water of spring-tides, is 8½ feet above the surface of the mud. A farther length of 917 feet is raised to about half its height, or from 4 to 6 feet; and the remaining portion, which is founded, is about a foot or 18 inches in height above the surface of the mud.

I have no information as to whether it be intended to carry out the building beyond the length already founded. There are no stones laid down beyond that distance to indicate any immediate intention of proceeding farther; but the stones at the end are not laid as if they were to form a permanent finish to the building. The length founded is exactly two-ninths of the whole width of the river. The surface of the mud-bank at the outer end is from 10 to 12 feet below the level of high-water of spring-tides; and the outer end of the dyke will, accordingly, if carried up to the same level as the inner end, be 10 or 12 feet in height. Considerable works were executed several years ago by Lord Kinnaird with the view of gaining land to the westward of the march dyke herein spoken of, and extending along the shore about a mile and a third, to Powgavie, where there is a small shipping harbour. These consisted chiefly of wickerwork fences, both at right angles and parallel with the shore, so as to intersect each other, and one running obliquely along the east side of the Pow. The plan shews the state of these two years ago; but considerable additions have been made, both to their number and their lengths since that time; and just now, in some places substantial stone dykes are being substituted for the wickerwork;—in particular, for that fence which runs out at right angles

with the shore to join the one running obliquely along the side of the Pow, and which, at the junction, extends about as far out from the land as the present end of the foundation of the March Dyke.

The area that would be enclosed between the March Dyke on the east, and the fence along the east side of the Pow on the west, supposing them not to be extended beyond their present lengths, would be 340 acres; but the effect in causing a silting up would be very great, both above and below these works, as well as upon the shore opposite the property of Lord Kinnaird.

The plan shows also the long dykes that have been at various times built on the estates of Seaside and of Errol.

I have the honour to be, Gentlemen,

Your most obedient servant,

JAMES LESLIE.

Further Statement prepared for the purpose of being submitted to Counsel.

From the bar or mouth of the river Tay to Dundee, a distance of 11 miles, the width at low-water varies from three quarters of a mile to about a mile and three quarters; and the narrowest place, viz., at Broughty Ferry, is nearly a mile in width at high-water.

Between Dundee and the confluence of the Tay and the Earn, a distance of 15 miles, the width of the estuary at high-water varies from three miles at Invergowrie Bay to one mile and a seventh at Newburgh, and to five-eighths of a mile above Mugdrum Island, immediately below the mouth of the Earn; and the area is about 17,800 acres, or 27¾ square miles. Of this area, about four-sevenths is dry at low-water of spring-tides, the remaining three-sevenths being under the level of low-water, or occupied by the fresh-water channel of the river.

The waters of the Tay and the Earn bring down with them a great quantity of alluvial matter, more especially during freshes; and there is, consequently, a very great tendency to deposit the matter held in suspension, wherever the velocity of the current is diminished by the river widening out into an estuary, and by its meeting the tidal waters of the ocean.

The sand and other heavy matter is frequently deposited in large quantities, even in mid-channel, wherever there is an eddy, or where the current has not sufficient strength to sweep it along; while the mud and other lighter particles can only settle down to the bottom in those places where there is neither much current nor wave; or, if it do settle down in an exposed situation during quiet weather, it is liable to be washed up again by the first jabble of a sea that breaks over it; but in perfectly sheltered situations, where there is no current, the deposit is extremely rapid.

The navigation at and below Dundee is kept open solely by the rush of the tidal waters into and out of the estuary being sufficiently strong to sweep away the sand brought down by the river; for the mere fresh water of the river alone would never suffice to keep down the bar, and otherwise to maintain the depth necessary for the lower navigation.

The channel of the united rivers above Mugdrum does not exceed 700 feet in width at low-water, or one sixth of the width at the strait of Broughty Ferry; and except during freshes, neither the depth nor the velocity is very great.

It is evident, therefore, that the body of water which finds an easy passage through this confined channel, would be of itself quite insufficient to serve as a scour to the mouth of the river; and that it is, consequently, of the utmost importance to maintain the full strength of the tidal current; and for that purpose to preserve entire the size and capacity of the estuary, and not to allow it to be encroached upon by artificial means.

Not many years ago, the Tay, after being joined by the Earn, used to run so strongly along the north shore, as to undermine and endanger the land; and a wall was required to be built along the foot of the water braes for their protection.

A late proprietor of the estate of Errol, seeing the difficulty and expense of keeping up these parallel dykes, altered the system to that of projecting dykes at right angles out from the shore; and these soon caused such a deposit of mud or sleek in the eddies produced by them, that a large space of land has been gained from the shore where there was formerly deep water; and the parallel dykes, which were formerly so indispensable, have been lifted to form embankments a long way farther out.

These cross dykes have been extended farther of late years, and one of them is now 1800 feet long.

This plan being found so efficacious both for the protection and the acquisition of land, has been adopted by many of the neighbouring proprietors, viz., by Sir John Richardson of Pitfour, Lord Kinnaird, and Mr. Hunter of Seaside, on the north shore; by Mr. Hay of Mugdrum on the north side of Mugdrum Island; and by Mr. Paterson of Carpow, and the predecesssors of the Earl of Zetland, on the south shore.

The magistrates of Perth, or the River Commissioners, have taken no steps to prevent encroachments on the north shore, or on the north side of Mugdrum Island, but rather seem to have encouraged them. They, however, lately brought an action against Lord Zetland to compel the removal of the dykes on his estate of Balmbriech, below Newburgh, on the ground that they formed sand-banks and impeded the navigation; although some of them had stood for about 40 years, and the longest of them was not one-fourth part of the length of some of those on the north shore; and, although, in consequence of the increased strength of the current along the south shore, caused by the partial shutting up of the channel north of Mugdrum, the land on the south shore was washing away, and stood much in need of protection.

The case came to a jury trial; and ultimately Lord Zetland's legal advisers gave up their case without making any defence; and the whole of the dykes upon the estate libelled, which included all that were of any value, required to be pulled down and removed.

It appears, therefore, that it is the object of the Perth authorities to narrow the river, and to confine it as much as possible to the south shore; and that, consequently, the trustees of Dundee Harbour need not trust to them for attending to the interests of the lower navigation.

It is, indeed, evident that there can be no community of interests in the matter. The navigation between Dundee and Perth, but more especially between Newburgh and Perth, is very shallow, and only available for a very small class of vessels.

It would be an object to get a few feet more depth of water; but the very most that can be got there must be much less than the depth at and below Dundee, even supposing that were diminished considerably within what it is at present. It is, therefore, for the interest of the people of Perth to

APPENDIX. No. 13.

narrow the estuary as nearly as possible to the width required for the passage of the river water, so that the channel might thereby be scoured proportionally deep; and the ulterior effects on the lower navigation are to them of comparatively little importance.

As regards Dundee, however, the case is very different. The trade of Dundee is carried on chiefly in large vessels, and a sum of 400,000*l.* has been expended in the construction of harbours and docks with sufficient depth for the accommodation of these vessels, which would in a great measure be lost if the lower navigation were allowed to be interrupted by shoals and sand banks; and shoals would inevitably arise there if the influx and reflux of the tide were stopped or materially lessened by the silting up of the estuary.

The trustees of the harbour of Dundee having, therefore, decidedly a beneficial interest in the tidal scour at and below Dundee, are undoubtedly entitled to interfere for the purpose of preventing the strength of the scour being lessened, and for that end to resist any encroachment on the estuary of the Tay, more especially those projections from the north shore which have a tendency to throw the strength of the current over to the south shore, and thereby to cause slack water in front of the harbour.

The property of Lord Kinnaird is situated on the north shore of the Tay, from 6 to 7½ miles above Dundee. The estuary is 2¾ miles wide at high-water opposite the east boundary, and 2 miles opposite the west boundary of the estate; and the mud-bank out to low-water is fully a mile and a half broad. Several years ago a number of wicker-work fences were constructed by Lord Kinnaird, extending across the bank, chiefly at right angles with the shore, but some also parallel with the shore, and intersecting the former; and one running obliquely along the east side of the Pow, a stream which runs into the river between his Lordship's property and that of Mr. Hunter, of Seaside, at the small shipping harbour of Powgavie. The Pow, instead of running directly across the bank, slants along shore to the eastward, so much that at the distance of four-fifths of a mile from Lord Kinnaird's west march, it is only three-fifths of a mile out from the land. The object of these works seems to have been to prevent the Pow from pushing its channel more to the eastward; but they were no doubt also undertaken with the view of acquiring land, and accordingly a great silting has taken place in consequence of them.

The work, now more immediately referred to, is a dyke which was commenced about the month of May last, upon the shore opposite the march between the properties of Lord Kinnaird and Colonel Paterson, of Castle Huntly.

The foundation of it is laid to the extent of 3110 feet, or four-sevenths of a mile out from high water mark and nearly at right angles with the shore; and a length of 410 feet of it is finished, and on a level with high water of spring tides. It is not known whether it be the present intention to carry out the building farther than the foundation is laid; but undoubtedly it was at one time in contemplation to extend it farther; and the outer end of the foundation does not show anything like a permanent finish. The length founded is exactly two-ninths of the whole high-water width of the river at that place, and the surface where the outer end stands is covered to the depth of 10 or 12 feet at high water of spring-tides.

Lord Kinnaird has been lately extending and increasing the number of the wicker work fences, and rendering them more permanent by packing them with stones, and for some of them he is now substituting substantial stone dykes; amongst others, for a fence of 2780 feet long, which extends directly out from high-water to join the oblique fence along the east side of the Pow.

The area that would be inclosed by joining the outer ends of the fence last mentioned, and of the new march dyke between the properties of Lord Kinnaird and Colonel Paterson, would be 340 acres; but the effect that would be produced by these works in causing a silting, both above and below, as well as upon the property of Lord Kinnaird, would also be very great.

Supposing a line to be drawn to connect the extreme ends of all the dykes, or other projections as they now stand or are founded on the north shore, and on the north side of Mugdrum Island as far up as the confluence of the Tay and the Earn; and supposing the space affected by the lowermost dyke, viz., that between Lord Kinnaird's property and Castle Huntly, to tail off to Monorgon point, the nearest headland on the east, at the distance of about a mile; the area that would be included within the line just described would be 1920 acres, or three square miles, which is equal to about one-ninth part of the whole estuary of the Tay between Dundee and the mouth of the Earn.

The area of 1920 acres here mentioned includes about 70 acres embanked within these seven years, and rendered arable opposite the estate of Errol, besides considerable spaces silted up between the dykes, and covered with reeds and salt grass on the north side of Mugdrum and elsewhere, but is exclusive of a great extent of ground embanked by Sir John Richardson opposite the mouth of the Earn, as I have no proper data for the measurement of that space of ground.

It is impossible to calculate, without having sections of the shores, what is the quantity of water that has been or would be excluded by these embankments and other works, as it does not increase in the same ratio as the area embanked or silted up, but depends as much upon the levels of the ground. It is evident, however, that since some of these works stand on ground which is covered to the depth of 10 or 12 feet at high-water, the quantity of water that would eventually be excluded by them would be so great as to have a decided influence on the strength of the scour at the lower parts of the river.

The accompanying plan shows the state of all the works herein described in summer 1841, and also the new dyke now building by Lord Kinnaird and Colonel Paterson, so far as it is founded; but it does not show the other dykes and fences constructed within these two years by Lord Kinnaird.

If the works before described be allowed to proceed and to remain without challenge, there is little doubt that similar works will be attempted on the north shore, still farther down; where, besides their injurious tendency, in common with the others, in diminishing the size of the estuary, their direct action will, from their vicinity to Dundee, be more immediately felt, in throwing the current still more strongly over to the south shore, to which it has too great a tendency already, and thereby in lessening the strength of the tide along the outside of the harbour.

JAMES LESLIE.

Dundee, 24th October, 1843.

Abstract of the foregoing Statement.

Mouth of the River Tay to Dundee, 11 miles.
Widths at low water, 1¾ to ¾ mile.
Ditto at Broughty Ferry at high water, nearly a mile.
Dundee to Earn mouth, 15 miles.

Widths at high-water—3 miles at Invergowrie Bay; 2¾ miles at the east boundary, and 2 miles at the west boundary of Lord Kinnaird's estate; 1¹ miles at Newburgh; ⅝ mile above Mugdrum.
Width at low-water at the narrowest, viz., below the mouth of the Earn, 700 feet—⅛ mile.
Area of estuary from Dundee to Earn mouth, 17,800 acres, or 27¾ square miles, whereof ⅐ dry at low water.
Lord Kinnaird's estate above Dundee, 6 to 7½ miles.
Length of new dyke between Lord Kinnaird and Colonel Paterson, 3110 feet.
Length of Lord Kinnaird's longest wicker-work fence, 2780 feet.
Area between the fence, along the side of the Pow, and the new dyke, 340 acres.
Longest dyke, opposite Errol estate, 1800 feet.
Area that would be included within a line drawn to connect the outer ends of all the jetties and Monorgan Point, 1920 acres, or 3 square miles—equal to one-ninth of the whole estuary between the mouth of the Earn and Dundee.

J. L.

No. 14.

Copy Letter—Adam Burnes, Writer, Montrose, to Sir James Carnegie, of South Esk, Bart., Kinnaird Castle.

"SIR, "Montrose, 20th December, 1842.

"I HAVE the honour, by directions of the Trustees of the Harbour of Montrose, to address you on the subject of the recent embankments made by you, or under your authority, in the basin or estuary of Montrose; whereby, according to the report of Mr. Rendel, founded on personal inspection and on the joint statement of the engineers, employed by you and the Harbour Trustees, it appears that upwards of 62 acres of ground have been taken possession of by you, to the injury and prejudice of the harbour of Montrose.

"I am directed by the trustees to intimate to you, that the Lords Commissioners of the Admiralty have been pleased to signify their approbation of the course recommended by Mr. Rendel, viz., that you should be permitted to complete the embankments in question, on the condition that you undertake the widening and deepening of the new channel of the South Esk River, and the whole other works described by the plan, sections, and specifications, which accompany Mr. Rendel's report; the whole, works referred to, to be commenced on or before the 1st day of April next, and to be completed at your expense on or before the 30th day of November same year, in every respect conformably to the said specifications and relative plan and sections, copies of which, as well as of Mr. Rendel's report, are already in your possession. I am therefore directed to request, that you will have the goodness to intimate to me in writing, within 14 days from this date, what course you mean to pursue in regard to the embankments in question, and, in particular, whether you intend to remove these embankments, or to adopt the alternative recommended by Mr. Rendel, of which the Lords of the Admiralty have signified their approbation; as you will observe from the accompanying copies of two letters, dated 9th and 14th instant, addressed to me by Sir John Barrow, one of the joint Secretaries to the Admiralty. I have also to intimate, that the present communication is made on the understanding that the expenses of the surveys and reports, and of any superintendence of works, and of the legal proceedings hitherto had, shall be defrayed by you.

"I am directed to assure you, that the Trustees of the Harbour of Montrose have no wish to interfere unnecessarily with the rights of yourself, or of any other proprietor, whose lands adjoin the Montrose Estuary, but as the local guardians of the Montrose Harbour (of which, as of other harbours in the kingdom, the Lords of the Admiralty are the public conservators), they feel it to be their duty to resist any encroachments or enclosure of ground on that estuary, not only as being illegal operations, but as calculated, in the opinions of the most eminent engineers, seriously to injure a harbour, which depends mainly, if not solely for its efficiency on the scour or the discharge of back water from the estuary to the sea.

"As certain legal proceedings are in dependance in the Court of Session relating to the encroachments in question, I am under the necessity of intimating that the present communication shall not be held to prejudice or affect these legal proceedings, nor the rights competent to the Lords of the Admiralty or to the Harbour Trustees to enforce the removal of the embankments in question, should the course recommended by Mr. Rendel not be followed out.

"I have the honour to be, &c.
(Signed) "ADAM BURNES."

"*Sir James Carnegie, of South Esk, Bart.,*
&c. &c. &c.

No. 15.

Mr. J. M. Rendel's Report on Montrose Harbour, 1842.

SIR, 34, *Great George Street, Westminster, 24th November,* 1842.

YOUR letter of the 18th July last, accompanied by sundry Plans and Reports, on the subject of an inclosure of tidal mudlands on the shores of the Montrose estuary, by Sir James Carnegie, of South Esk, baronet, with instructions to me to report thereon, as suggested by the Lords Commissioners of the Admiralty in the Hon. Sidney Herbert's letter of the 15th July, in reply to your letter and memorial of the 6th, reached me at Dundee on the 20th July; and on the 23d I proceeded to Montrose, and in company with Mr. Leslie, the engineer to the Harbour Trustees, and Mr. Blackadder, the engineer appointed by Sir James Carnegie, to execute the embankments complained of, I made a close inspection of the works both at low and high water, and of the shores and channels of the harbour from thence to the sea.

Finding that Mr. Leslie and Mr. Blackadder differed in opinion on points which I deemed important to the inquiry, an actual survey, including a measurement of the ground embanked, and a

Appendix. No. 15.

series of tidal observations jointly executed by those gentlemen, became a necessary preliminary to any farther proceedings. On the 26th September last, I received the results of their survey, properly authenticated, which, with all other papers submitted to me, I have well considered, and now I beg to submit the following Report.

The estuary in which the works under consideration have been made, is of that class which the sea has formed by throwing up banks of sand across the mouth of a deeply recessed bay, converting the space within into a kind of tidal basin, or salt-water lake. The channel which connects it with the sea constitutes the harbour of Montrose, which is kept deep and commodious by the great quantity of water running through it between the sea and the basin, during the flux and reflux of every tide.

This brief but general description will suffice to show that a mutual dependence subsists between the harbour and the estuary. For instance, supposing the harbour to be contracted by injudicious works, so as to prevent a full flow of tide into the estuary, its shores and elevated parts being no longer flowed over, would be covered with vegetation, and rapidly become productive land; and supposing the estuary encroached on in a manner to reduce the quantity of water passing through the harbour, its depth and capacity would, as a consequence, be correspondingly diminished.

Now, it appears from the joint survey of Mr. Leslie and Mr. Blackadder, that the embankments making by Sir James Carnegie, have reduced the area of the estuary upwards of 62 acres, and the quantity of tidal water flowing into it at spring tides, upwards of $10\frac{1}{2}$ millions of cubic feet, and at neap tides nearly 3 millions of cubic feet. It follows, therefore, as a consequence, deducible from the preceding description of the harbour, that this great loss of backwater will be the cause of injury, and that the interference of the harbour trustees was a proper and necessary measure.

The restoration of the land embanked is perhaps the only remedy that can be legally insisted on. I am not, however, prepared to recommend it as the best. I would suggest, as a preferable course, that Sir James Carnegie should be permitted to complete his embankments, provided he will undertake the widening and deepening of the new channel of the South Esk river, to the extent described by the plan, sections, and specification, which accompany this Report.

The adoption of this compromise, though leaving a loss of backwater at spring tides of upwards of 7 millions of cubic feet, will give an increase of $2\frac{1}{2}$ millions cubic feet at neap tides; whilst from the excavations it imposes being at a level considerably below the greater portion of the embanked mudlands, the water gained will be more beneficial to the scour of the harbour and estuary, than an equal quantity of that which has been taken away.

That it will be the interest of Sir James Carnegie to adopt this compromise is sufficiently manifest, and I would strongly recommend it to the preference of the harbour trustees, under the circumstance of their having sanctioned the diversion of the South Esk river, which, in the course of years, would infallibly have led to the silting up of its old channel, and the adjoining mudlands, which comprise the whole space now embanked.

In conclusion, I feel it my duty to echo the recommendation given by Mr. Walker to the harbour trustees, in his Report of the 18th January, 1839, that they should watch with jealousy any attempt at encroachments of the shores of this estuary; and as the most effectual means of rendering such watchfulness operative, I would recommend that it should be an instruction to their harbour master to make the circuit of its shores at least monthly, and present a written report on the result.

And farther, that as a means of knowing with exactitude any changes occurring within it from natural causes, levels should be taken on numerous lines between well defined and permanent marks on the opposite shores, from which sections should be laid down and preserved as official documents, so that by a repetition and comparison, every three or four years' changes in its bed and channel, however minute, might be noted and registered.

These are precautions which the importance of the harbour fully justifies, and which its nature requires.

I am, Sir,

Your most obedient Servant,

(Signed) James M. Rendel.

To Adam Burnes, Esq., Clerk to the Harbour Trustees.

Specification of Works to be done in widening and deepening the Channel of the River South Esk, between the Bridge of Dun and Old Montrose.

1st. The present channel of the river is to be widened, and otherwise formed, to correspond in dimensions and shape with the plans and sections attached hereto.

2nd. The whole of the soil required to be removed in executing the works described, is to be taken to such parts of the low ground within the new embankment made by Sir James Carnegie, Bart., as his engineer, or agent, may from time to time direct. Or if such engineer, or agent, shall deem the excavated soil unsuitable for levelling the embanked land, then the contractor must remove it to such place as the engineer appointed by the Montrose Harbour Trustees may approve, the deposit being made beyond the reach of the highest known tides, and in such manner that no portion of the excavated soil shall be liable to fall, or be thrown into the estuary.

3rd. That both slopes of the new channel, from the bridge of Dun to the letters Y Z on the plan, are to be coated or protected with whinstone, in the same way, and to the like extent and thickness as the north-west end of the new embankment, where it crosses the old channel of the river.

4th. In case any of the soil required to be excavated in the execution of these works, shall, either from accident or neglect, be washed away by the river, a quantity of soil equal thereto shall be removed from some other part of the estuary, as may be decided on and pointed out by the engineer of the harbour trustees, and the place of deposit for the soil so to be removed shall also be determined by the said engineer, but as near to the place where the excavations are required to be made, as a compliance with the restrictions already specified as regulating the deposit of soil will admit of, and

5th. The works are to be commenced on or before the 1st day of April, 1843, and must be completed on or before the 30th day of September of the same year, under the joint superintendence of the engineer to the harbour trustees, and the engineer to Sir James Carnegie; and in the event of any difference or dispute arising between them as to the meaning or intention of any part of the plans, sections, or these specifications, the same shall be referred to an engineer to be named by the Lords

Commissioners of the Admiralty, and his decision to be final and binding on Sir James Carnegie and the harbour trustees.

No. 15.

(Signed) JAMES M. RENDEL.

34, *Great George Street, Westminster,*
24th November, 1842.

A true Copy,

ADAM BURNES,
Clerk to Trustees of Harbour of Montrose.

No. 15 *a.*

Memorial for the Trustees of the Harbour of Aberbrothwick, in the County of Forfar.

The Memorialists have, by persevering exertion, and at considerable expense, succeeded in enlarging and greatly improving the Harbour of Aberbrothwick, but they find themselves, from the want of funds, altogether unable to accomplish important parts of their plan. There are still works to complete, particularly the deepening of the harbour and its entrance and approaches, without which the great public benefits which the improvement of the harbour is calculated to confer will be in some measure lost. The position of this harbour is such, as shall be afterwards adverted to, that independently of its importance to a large and populous district, it could easily be made a harbour of refuge, where a harbour of this description is most wanted, and might thus become a national object; and considering the efforts made by the parties locally interested, and what they have accomplished, the Memorialists venture to entertain the belief that there is a well founded claim on the Government for encouragement and assistance in their present difficulties.

The Memorialists were incorporated under the Act 2 Vict., cap. 16. At that time the Harbour of Aberbrothwick belonged to the Magistrates and Town Council of the Burgh. "The piers, quays, and other works of and within the harbour had become insufficient for the accommodation of the shipping and trade of the burgh, and they were unfit for the reception of vessels of any considerable size." Application was, therefore, made to Parliament, and the Act referred to was passed, appointing trustees, with power to acquire the right to the harbour from the Magistrates and Council, to take the administration of the harbour, and to carry out the plan for its extension and improvement. For these purposes the trustees were authorized to borrow and take up at interest, not exceeding the sum of 50,000*l.*, on the credit of the harbour, and rates, and duties, and other revenue and property of the same.

The Memorialists have, to the utmost of their power, carried into effect the objects of the Act. They have repaired and greatly improved and enlarged the harbour, having constructed a sea wall, and a new outer harbour, and other works, whereby the accommodation for the shipping and trade of the port has been much more than doubled.

In carrying on these works, the Memorialists have already expended a larger sum than the whole funds provided are adequate to pay. As before stated, the sums authorized to be borrowed under the Act of Parliament are limited to 50,000*l.* Up to this time the Memorialists have expended on the works contracted for and executed by them (including 10,000*l.* paid to the Magistrates and Town Council for the Old Harbour) not less than from 57,000*l.* to 58,000*l.* A part of this outlay, to the extent of from 4000*l.* to 5000*l.* has been liquidated by means of the surplus revenue for the last few years. But the mortgage debt amounts to 50,000*l.*, and there is besides upwards of 3000*l.* due to the contractors and others, for the payment of which no funds are yet provided. The Memorialists have been enabled to do so much by the cordial encouragement and support they received from the inhabitants of the town and immediate neighbourhood, whose public spirit has been manifested throughout in an extraordinary degree. It has been mentioned that the harbour formerly belonged to the Magistrates and Town Council. Its revenues were then applied to the ordinary purposes of the Burgh, and this application of them enabled the magistrates to administer municipal affairs, and to defray the expense of watching, lighting, paving, &c. without any tax being levied on the burgesses and inhabitants. But so zealous were all parties in the design of extending and improving the harbour, that public meetings of the burgesses and inhabitants were held, at which it was unanimously resolved to adopt the provisions of the General Police Act, and so transfer the burden of lighting, watching, paving, &c. from the Burgh funds to the inhabitants, with the understanding that the administration of the harbour should be vested in Parliamentary Trustees, and its revenues devoted exclusively to its own purposes. And as the Burgh had contracted a considerable sum of debt, chiefly in the repair and improvement of the old harbour, it was agreed that such a moderate compensation as might meet that debt should be given to the magistrates and council for renouncing their right to the harbour and its revenues. Upon this footing, and with the magistrates and council for its promoters, the Act of Parliament under which the Memorialists were appointed was obtained. And it was not only in this instance that local exertions were made, and burdens submitted to, for when it became necessary to raise funds on the credit of the harbour and works, in order to carry out the intended improvements, those of the inhabitants who could conveniently do so advanced money on loan to a considerable amount, while many others came forward and gave their personal guarantees for repayment of the advances obtained on a bank credit in name of the Memorialists. The amount of the guarantees given by individuals in this way was not less than 24,000*l.*; and their obligations are still existing undischarged.

After all these exertions, there still remain of the works to be executed the *conversion of the inner or old harbour into a wet dock, and the deepening of the harbour and its entrance and approaches.* The former improvement may be deferred for a time at least, but the latter, *the deepening of the harbour and its entrance and approaches*, has become so pressing, and of such vital importance, that the Memorialists, under the circumstances in which they are placed, are constrained to take measures for bringing the case under the consideration of Government, in the hope that it may be held to justify and call for their interference and aid, as a matter affecting the public interest. The Memorialists, and the community with which they are connected, have done their utmost, and it is only after having entirely exhausted their own resources, that they ask for public support.

They have no remedy in a renewed application to Parliament for power to raise a further sum of money, because such an application would be unavailing, unless the Memorialists could show that

Appendix.

No. 15 *a*.

their revenue warranted the outlay; and although Parliament were to grant the power, loans could not be effected without adequate security, which at present the Memorialists have no means of giving.

A plan of the harbour, as it now stands, accompanies this Memorial. Previously to the commencement of the recent improvements, the harbour was insufficient in every respect. There was a want of sufficient depth of water, and the quays and wharf walls were in bad order, and the jetty at the entrance was in a state of dilapidation. The want of accommodation, by reason of the smallness of the harbour, was such that it was frequently crowded to excess; at times the ingress was completely stopped up, and the trade of the town at a stand. The larger class of vessels had mostly to winter in other ports. These last-mentioned inconveniences have been in a great measure removed. The improvement effected by the Memorialists has for the present provided abundant accommodation within the harbour. But the complaint of a want of a sufficient depth of water in the harbour, and its entrance and approaches, remains in full force, and is the more grievously felt that it is a total barrier to the enjoyment of the advantages of the improved harbour. There is only a depth of 11 and 12 feet at the entrance at ordinary spring tides, and only 8 or 9 feet at ordinary neap tides. Vessels of 150 tons and upwards (of which there are a number belonging to the port) cannot enter or leave the harbour but at the height of the spring, and those of smaller burthen are often detained for several days waiting the tides. The works of the new harbour have been constructed in contemplation of the entrance, &c., being deepened from 4 to 6 feet, and were this accomplished, there would be from 17 to 18 feet of water at ordinary spring tides, in place of from 11 to 12 feet as at present.

The harbour is situated on the German Ocean, and on a rocky and dangerous coast. From the point at the extremity of the new return head of the sea wall towards the sea, the ground is quite flat for nearly a quarter of a mile till it reaches what is termed *the Bar*, beyond which the depth of water increases rapidly. The flat ground is quite dry in spring tides, and presents no difficulty to the deepening of the channel. That a safe harbour, accessible to vessels of considerable size, would at this point be of immense benefit to the extensive and populous district with which it is immediately connected, is perfectly obvious; and it is no less certain that it would be an object of national importance. The greater part of the east coast of Scotland is well known as presenting continued ranges of precipitous rocks; and with the wind on a lee shore, this coast is extremely dangerous. The entrance to the Tay is frequently no less hazardous, and the destruction of property and loss of life on the banks in that river have been of late years very great. From the body of fresh water issuing from the Esk and the Dee, and with the wind on the land, it is found difficult to take Montrose or Aberdeen. If, therefore, the projected improvements at Arbroath were completed, its harbour would be a great national benefit as a harbour of refuge to the whole east coast of Scotland.

Aberbrothwick, or Arbroath, as it is commonly called, is now a flourishing and populous town, the seat of extensive manufactures, and is daily increasing. In the year 1742 it contained only 2500 inhabitants; it now contains a population of about 15,000.

The old harbour was built about the year 1725, and had then belonging to it only a few vessels engaged in the coasting trade. During the year ending in October, 1843, which had been one of depression in the trade of the district, the number of vessels reported inwards from Foreign Ports was eighty-nine; and the total number of vessels that entered the harbour was 749. In 1727, the shore-dues of the Port amounted to 25*l*. 1*s*. 8*d*.; in 1746, they were only 20*l*. 16*s*. 8*d*.; in 1793, they were 293*l*.; in 1803, they were 370*l*.; in 1813, they were 731*l*.; in 1823, they were 615*l*. 15*s*.; in 1833, they were 1312*l*.; in 1843, they were 3050*l*. Further statistical details will be found in the accompa- documents, viz.:—

1. Abstract of shore-dues of the harbour of Aberbrothwick annually, from 1727 downwards.
2. Printed copy memorial and petition by the magistrates and others, to the Lords of the Treasury, for having Arbroath declared a free port—1844.
3. Abstract of the harbour accounts for the year 1840.
4. Ditto ditto 1841.
5. Ditto ditto 1842.
6. Ditto ditto 1843.

The Memorialists respectfully submit the present statement, with the view of its being made the means of drawing the attention of Government to the circumstances, and in the confident hope that if known and appreciated, these circumstances would be held sufficient to call for and justifiy a grant of public money for purposes so highly desirable and important.

James Gibson, *Chairman*.

Arbroath, 1*st November*, 1844.

Estimate of the probable Expense of deepening the old Harbour of Arbroath two feet, and the new Harbour, with the entrance thereto, three feet, each Division being excavated, on an average, to these depths, although some parts may require more, and others less excavation, to give a fair and uniform bottom sloping regularly outwards to the deep water.

	£.	*s*.	*d*.
Old Harbour, 5,600 cubic yards, at 1*s*. 3*d*.	350	0	0
New Inner Harbour, 13,654 cubic yards, at 1*s*. 6*d*.	1,024	1	0
Outer Harbour, as far as the old Breakwater, 4,451 cubic yards, at 2*s*.	445	2	0
Channel out to the Outer Heads (chiefly rock), 4,155 cubic yards, at 2*s*. 6*d*.	623	5	0
Fairway beyond Outer Heads, widening out to 600 feet at the outer edge of the bar (rock and boulders), 28,666 cubic yards, at 4*s*.	5,733	4	0
	8,175	12	0
Contingencies 10 per cent.	817	11	0
	£8,993	3	0

Say £9,000.

James Leslie.

London, 29*th April*, 1845.

ACCOUNT of the ARRIVALS and SAILINGS of Foreign and Coasting Vessels, of 11 feet draft of water and upwards, at Glasgow Quay, during the Year 1844.—(Extracted from the books of the Harbour-Master.)

VESSELS.	11 feet.	12 feet.	13 feet.	14 feet.	15 feet.	16 feet.	17 feet.	Total.	
Inwards, Foreign .	32	25	33	33	23	22	3	171	
,, Coasting .	155	66	6	2	..	..	..	229	
								—	400
Outwards, Foreign.	48	65	44	68	51	20	..	296	
,, Coasting	148	84	10	3	1	..	..	246	
								—	542
Total Arrivals and Sailings of 11 feet draft and upwards									942

In 1844 the number of arrivals, of all classes, at Glasgow Quay, was Vessels. 13,919 of Tons. 1,101,949

(Signed) JAMES JOHNSTONE.

Glasgow, 12th July, 1845.

No. 16.

Statement respecting the Forth Navigation to Alloa and Stirling.

Question 1836.—The guarantee which the Navigation Commissioners can give for payment of the interest of any money which may be advanced to them, and the repayment of the loan, are the rates authorized by the Act to be levied on vessels sailing between Stirling and Alloa, and the cargoes carried by them, and on passengers by steam-boats. The rates at present levied on vessels and goods are one-third only of those contained in the schedule of rates annexed to the Act; and no more than this third can be levied until 5000*l.* are expended for the purposes of the Act. On this being done two-thirds can be levied and no more, until a further sum of 4000*l.* is expended, and then the full rates authorized by the Act can be drawn.

The rates for the year from 15th May, 1844, to 15th May, 1845, were let for 350*l.*, and for the current year, from 15th May, 1845, to 15th May, 1846, they are let for the same sum to the same tenant, and he is considered to have a good bargain. Supposing, however, the rates to advance no higher, in present circumstances, being £350

Deduct for steam-boat passengers from whom the full dues are at present drawn .	100
	250
On 5000*l.* being expended this sum will be doubled (*being the second third*) . .	250
Add steam-boat passengers	100
	600
And on an additional 4000*l.* being expended another third, being the full rates, may be levied	250
	£850

From this it appears that were 10,000*l.* to be advanced by the Treasury for the purposes of the Act, at 3 per cent. there would be a sufficient revenue for the dues, *even although there were no addition to the present traffic*, to pay that interest, being £300

And a sinking fund for the redemption of the loan of 4 per cent.	400
	700
Leaving a surplus of	150
	£850

The above is the revenue that would be derived from the rates, even if the traffic remained stationary at its present amount. But that a very great addition would arise if the obstacles to the navigation were removed, there cannot be a moment's doubt. Even at present a number of large vessels carrying grain, timber, and iron, wool, &c., for Stirling, are obliged to unload their cargoes, or part of them, at Alloa, Grangemouth, and at a creek called Fallin, near Alloa, which are carted at heavy charges from these places to Stirling. From inquiries that have been made, the Commissioners have reason to believe, that traffic to an extent of not less than one-third of the present traffic by water to Stirling, is unshipped at the harbours below Stirling, and carted thereto. If, therefore, the loan required were given, and the amount laid out in the improvement of the navigation, there would, to the annual revenue which will be produced from traffic of the same amount as at present charged on vessels and goods at the full rates, being £750

And steam-boat passengers	100
Be added, the rates from the above additional third of vessels and goods, being .	250
In all	£1100

This is without taking at all into account the increased trade, which the facilities arising from the improved navigation would bring. In almost every instance this has been the result of improvements of other rivers; and the situation of the harbour of Stirling affords a certainty almost, of such being the case were the Forth improved. Situated as it is at the mouth of the highlands, in the heart of one of the most fertile and best cultivated districts in Scotland, of which Stirling is the chief town, and surrounded by numerous manufacturing villages, which are daily on the increase, there is no port which affords better prospects of becoming an important place of trade, if the access to and from it by the river Forth were improved, as recommended in the Report of Mr. Stevenson.

Question 1848.—The Commission asks the sources from which the present dues are derived? The

APPENDIX.

No. 16.

Commissioners of the Forth Navigation have been unable to procure an exact account of the *present* traffic, but they send herewith a copy of a statement of the entire traffic in the years 1840–41 and 1841–42, made up by the person by whom the old harbour dues were rented. This will give the Commission an idea of the kind of traffic, and also of the extent, and at present it is believed to be much the same, with a considerable addition on the quantity of limestone imported.

The shipping belonging to Alloa and Stirling, exclusive of three steam-boats, together 251 tons, of which one-half belongs to Stirling, and one-half to Alloa, is as follows:—

	No.	Tons.
To Alloa	99	17,392
To Stirling	24	1,048

But of those 99 belonging to Alloa a great many are not engaged in the trade to and from Alloa. Those belonging to Stirling are all engaged in trading within the bounds of the Forth Navigation Act. The number of arrivals and sailings of vessels to and from Alloa and Stirling for the year from 15th May, 1844, to 15th May, 1845, are as follows:—

	Arrivals.	Sailings.
From Alloa	526	520
From Stirling	806	806
From Alloa and Stirling, steam-boats	492	492

A great part of the sailings from Stirling are empty vessels which, after unloading their cargoes of limestones, building-stones, &c., depart immediately for a new cargo. These vessels are of comparatively small burden, which is absolutely necessary in the present state of the river; but if the fords were removed larger vessels would be used, from which a great saving would be effected by the lime-burners, farmers, builders, &c.

Stirling, 10*th July*, 1845. WM. GALBRAITH.

No. 17.

No. 17.

Her Majesty's Ship "Blazer," Grimsby,
18th June, 1845.

SIR,

I LANDED to-day on the Spurn Point with Mr. Calver, Master of the "Blazer," and Mr. Cubitt, C. E., to make the inquiries you ask for with respect to shingle.

We found seven vessels on the beach loading with shingle for road-making, they were each about 60 tons, and can get a load in one tide. They pay 1*l.* per load to Sir Clifford Constable, the Lord of the Manor, for the privilege of loading, and 1*s.* per ton to the crew of the life-boat for getting the shingle on board. The price obtained for it varies, but may average 3*s.* per ton.

From all we could learn there appear to be on an average four or five vessels a-day loading on the beach, which would give, after making every allowance for bad weather, a larger quantity of shingle removed than the 35,300 tons mentioned in your letter.

The vessels are not allowed to touch the shingle within 300 yards on each side of the low lighthouse, in front of which the beach has changed very little since its erection on its present site.

The Spurn Point now appears to be stationary, but has, from the light-keeper's account, been diminished in width full half during the last 20 years.

I am, &c.
(Signed) OWEN STANLEY, *Captain.*

No. 18.

No. 18.

The actual Expense Paid out by the Contractor for Dredging Yarmouth Harbour, from April to December, 1831, *as furnished to Mr. Stead.*

	Tons.
Steam-engine raised	137,706
Horse-engine raised	71,844
Total	209,550

	£.	*s.*	*d.*	£.	*s.*	*d.*
Wages, working steam	209	2	7			
Labourage, landing	1,324	14	0			
				1,531	16	7

Or per Ton $2\frac{6\,6}{1\,0\,0}d.$

Wages, &c., working engine (horse)	181	13	0			
Labourage, landing	673	16	3			
				855	9	3

Or per Ton $2\frac{8\,5}{1\,0\,0}d.$

Raising 209,550 tons, costs £2,387 5 10

Without any payment or allowance for wherries or punts used, (usually about $1\frac{1}{2}d.$ per ton)—but the above includes all labourage, landing, &c.

Yarmouth, December, 1831.

AN ABSTRACT of the Account of Mr. Joseph Berry Edwards, the Treasurer to the Commissioners of Southwold Harbour, for the Year ending the 24th June, 1842, audited Quarterly by a Committee appointed for such purpose, 11 Geo. IV., c. 48.

RECEIPTS.	£.	s.	d.
1841-2.—Dues on 12,379 tons 9 cwt. coals, at 1*s.* 2*d.*	722	2	5
Ditto on 26,230 qrs. corn, at 2*d.*	218	11	8
Ditto on goods, &c.	128	19	6
Ditto on 2,330 tons of ballast.	87	7	6
Tonnage dues	0	14	8
1842. June 24. Balance due to Treasurer	149	19	0
	£1307	14	9

EXPENDITURE.	£.	s.	d.
1841. June 24. Balance due to Treasurer	199	18	9
1841-2.—Cash paid on various accounts, viz.:			
For iron and blacksmith's work, &c.	100	3	11
For labour, &c., as per surveyor's book	480	0	0
For interest on money borrowed	54	16	10
For salaries and law expenses	162	8	6
For timber, &c.	272	16	3
For rope, yarn, oil, pitch, &c.	9	6	7
For rent of office	10	0	0
For stamps, printing, and advertisements	10	17	1
For miscellanies	7	6	10
	£1307	14	9

The foregoing account was submitted to the Commissioners, assembled at their annual meeting, at the Old Swan Inn, Southwold, the 21st day of July, 1842.

(Signed) STRADBROKE, *Chairman.*

(Countersigned) HARRY WHITE, *Clerk.*

COMPARATIVE STATEMENT of the HARBOUR DUES paid by the Southwold and the Halesworth Trade during the last 30 Years, from Parliamentary and Harbour Returns.

Dates.	Southwold Trade.	Dues. £.	s.	d.	Halesworth Trade.	Dues. £.	s.	d.
1810	190,790 Qrs. Corn	2,011	6	8	39,482 Qrs. Corn	380	9	0
1819	36,165 Chalds. Coals	2,976	8	8	26,897 Chalds. Coals	2,236	0	0
		4,987	15	4		2,616	9	0
1820	243,302 Qrs. Corn	3,041	5	6	71,843 Qrs. Corn	898	0	9
1830	34,221 Chalds. Coals	3,421	13	0	36,947 Chalds. Coals	3,694	14	0
		6,462	18	6		4,592	14	0
1831	105,262 Qrs. Corn	877	3	8	152,185 Qrs. Corn	1,268	14	2
1840	23,295 Chalds. Coals	1,811	16	8	46,397 Chalds. Coals	3,608	13	6
		2,689	0	4		4,877	7	8

Expense and Method of Dredging.

Patrick Stead, Esq.

Perth, 23rd October, 1839.

DEAR SIR,

YOURS of the 19th received. We have again waited on the clerks of the River and Harbour Commissioners: they are of the same opinion as formerly—that the dredging cost only about 2½*d.* per ton. Annexed you have a calculation, by one of the Commissioners, who has taken a very great deal of trouble in this business for the last five years. The dredging apparatus and punts all belong to the Commissioners.

(Signed) WRIGHT AND CURRIE.

Report sent us.

The establishment under the Perth Harbour Commission, for dredging the river Tay, is a dredging machine, with a cover for 14 men: chief foreman, 5*s.* per day; second ditto, 3*s.* 4*d.*; the remaining 12 from 3*s.* 2*d.* to 2*s.* 7*d.* 24 punts, from 25 to 32 tons (average 30 tons), with a crew of 24 men: chief foreman, 3*s.* 6*d.* per day; second, 2*s.* 8*d.*; the remaining 22 from 2*s.* 2*d.* to 2*s.* 4*d.* Total wages per week, when full employment, 25*l.* The machine works during certain stages of the tide, and to load 18 punts is considered a fair tide's work, two tides work every 24 hours. Sometimes 23 punts have been loaded in one tide. The machine turns out not less than 5,800 tons a week for 30 weeks out of the 52. This quantity, at 2½*d.* per ton, is 60*l.* per week, leaving 35*l.* for coals, wear and tear of the machine and punts, interest of money, &c. Our time for deepening was five years, but we have got other two years given us—seven years altogether—so that I anticipate the lifting and depositing a ton of gravel will not exceed 2*d.* or 2¼*d.*; and meeting with clay or sludge the work is somewhat retarded—if clay, 3*d.* to 4*d.*

P. Stead, Esq.

Perth, 9th October, 1844.

SIR,

THE improvement in deepening by cross dredging on the river Tay is in preference to dredging ahead. In cross dredging we only take about a foot in depth at a time, at the same time leaving the bottom as level as when we commenced; and by going over the shallows in spring tides, we come over it again when the tides take off, which gives a great advantage over head dredging. We can have a foot of water over a shallow in the half of the time, and likewise sure there are no ridges, stones, nor wood left to obstruct the navigation. At the rate our machine goes we clear about 680 square yards, one foot in depth, in a tide's work of five hours.

(Signed) JOHN NORWELL.

No. 19.

Mr. Chitty's Opinion as to Embankments.

CASE.

The Act of Parliament of 30 Geo. II. cap. 47, being "An Act for making the River Blyth Navigation from Halesworth Bridge, county of Suffolk, into the Haven of Southwold," is left herewith.

Also the Act of 11 Geo. IV. cap. 48, A.D. 1830, being "An Act for more effectually improving the Harbour of Southwold," and whereby the former Acts of the 30 Geo. II. cap. 58, 29 Geo. III. cap. 77, and 49 Geo. III. cap. 77, are repealed.

Also the printed Report of Rennie, the engineer, of the 6th January, 1820, as to the encroachments and embankments which have been made and suffered, stopping up the creeks and narrowing, &c., the channel, and impeding the navigation of the said river Blyth, and thereby greatly injuring and blocking up the Southwold Harbour, and wherein he states the imperative "necessity of preventing such embankments for the future," and that to destroy the embankments already made, and to allow the tide-water to flow into its ancient receptacles, is the most obvious and effectual remedy that could be devised.

This has not, however, been done, the Commissioners having taken no steps whatever to remedy the evil and nuisance, whereby the harbour of Southwold has of late years been getting much worse than ever, so much so, that no water has ebbed or flowed in it for a week's continued duration. Vessels and crafts have been completely blocked up inside, and ships inward bound have been kept out driving about the roadsteads to their imminent danger, and compelled at serious risk to seek shelter in the neighbouring creeks, and are so at this present time lying beating upon the bar to their great damage and risk.

The Commissioners appointed by the aforesaid Southwold Harbour Act are almost entirely composed of land-owners and clergymen, having little or no interest in the commerce from whence the funds provided for the reparation and good keeping of the harbour is derived, and the ship-owners and mercantile rights and interests have been so neglected to their grievous loss and injury.

It will be observed by Mr. Rennie's Report, that 1100 acres over which the tide used to flow have been embanked, of which 550 are ancient embankments and 200 more were embanked 50 years ago, and that the remaining 350 were embanked at the following later periods, viz., 100 in 1780, 100 in 1804, 100 in 1807, 43 in 1818, and that 200 acres are about the quantity now contained within the present embanked channels, creeks, &c., so that the force of the current has become diminished in the proportion of 10 to 4.

These encroachments and embankments are within the limits of the River Blyth Navigation Act. They cause the injury complained of to the harbour, as will be seen by Mr. Rennie's Report.

Under the above circumstances, one of the gentlemen connected with the mercantile interest requests Mr. Chitty's opinion, with a view to adopt the most advisable measures for obtaining and compelling the removal of the embankments and obstructions, or for enforcing other sufficient remedy, and he also wishes to be informed fully of the rights and powers which he and the public have to effect that object, and how and by what process and at whose prosecution or suit it is to be obtained, and whether there is any and what limitation of time as respects any such penalties or responsibility.

And having referred to the General Harbour Act of the 46 Geo. III. cap. 153, A.D. 1806, whether such persons as have, since it was passed, made embankments without conforming to the provision, as to give one month's previous notice to the Secretary of the Admiralty, are not liable to penalty and prosecution, and what proceeding can now be taken, and by whom, and whether there be any limitation of time for commencing such proceedings.

Upon all the above matters Mr. Chitty's opinion is particularly requested, and he will much oblige us by citing or enumerating the names of the cases and reports thereof, or of the principal ones where any proceedings have taken place on the illegal acts above mentioned, both as regards encroachments and embankments, whether by information, indictment, action at law, or otherwise.

OPINION.

It appears to me, under the circumstances stated, that the embankments and obstructions in question are public nuisances, as being an injury to the harbour and the passage of ships. As such nuisances, they may be abated and removed; or the erectors or maintainers of them may be indicted, or have a criminal information filed against them; or if any individual has sustained any special injury arising from them (as by the detention of his ships in the harbour or the like,) he might maintain a special action on the case against them of these remedies. I should, at all events, for the present, advise the adoption of the one by indictment only, which may be prosecuted at the instance of any individual who may think fit to resort to it.

I should advise the indictment to be against the parties who have erected or maintained the most recent of the embankments causing the nuisance. I do not think that the length of time during which the embankments have existed will legitimize them: Weld v. Hornby, 7 East, 195; R. v. Cross, 3, camp. 227; Coupland v. Hardingham, id. 398; Vooght Winch, 2 b. and ac. 662.

There is no limitation of time for the prosecution by indictment. The responsibility to an action at the suit of any party specially injured, would cease at the end of six years from the occurring of that injury.

Those persons who erected the embankments since the 46 Geo. III. was passed may, I think, have subjected themselves to the penalty imposed thereby.

The following Statements are those referred to in Question 1362 *(Lieut. Ellis's Evidence).*

James Fisk, aged 64, marshman, states that for the last 28 years he has worked wholly for the Earl of Stradbroke. Recollects the enclosing of the Bulchamp Marshes about 40 years ago, and worked at it. Before the embankment began, he was at work at Southwold, opening the harbour, which was then blocked up, so that ten waggons abreast might go across there. The harbour, was in that state for some weeks, and was occasioned by the N.E. wind, and continued until a N.W. wind came. Never heard any remarks made at the time of the enclosing, nor don't know of any difference in the harbour from the embankments. The tide is now as good and strong as ever it was. About half the land was covered with water, and at high water spring tides the whole was covered about one foot. The water runs up in the river now as high as ever it did.

Blythborough, July 8, 1844.

James Sterry, aged 81, formerly a Trinity Pilot, now deputy harbour master, and many years principal harbour master. Sixty years ago, used to lighten vessels in the roads drawing eight or nine feet to enable them to enter the harbour, and outward bound vessels were obliged to load up outside the harbour. On one occasion, when a boy, he laid 12 weeks in the harbour ready for sea, in a vessel drawing 8½ feet water, laden with corn. The embankments made in his time, made no difference in the harbour. In 1784–5–6, the harbour was worst in his recollection, a lighter was built expressly for lightening vessels, to enable them to get over the bar, and coal vessels coming from the north, were entitled to the turn according as they arrived off with the High Street open.

Southwold, July 8, 1844.

Return of Books of Account kept by the Officers under the Commissioners of Southwold Harbour, and produced before the Tidal Harbours Commission.

1. *Treasurer's.*—Debited with the collections paid by the collector, and other receipts, and credited with the payments for timber and materials, labour, salaries, interest of money borrowed, and all other outgoings.
2. *Surveyor's.*—Debited with the checks drawn on the treasurer, and credited with the amounts paid weekly for wages of carpenters and labourers, dredging, &c.
3. *Surveyor's Materials' Book.*—Debited with the supplies of timber and materials, and other property of the harbour, in which are noted the cost, marks, quality, and dates of the articles received, and credited with the same when expended. The stock is taken periodically, and the articles shown how and for what purpose expended.
4. *Collector's.*—Debited with the amounts collected for harbour duties, and shown in detail, and credited with the payments made to treasurer; and a return made to treasurer of amount paid by each vessel, for him to check the same with the arrivals and sailings.

The treasurer gives bond in the amount of 3000*l.*, and the collector 300*l.*

The accounts are audited quarterly by a committee appointed at each annual meeting; and all bills are submitted for inspection and allowance before they are paid.

FRANCIS W. ELLIS.

London, June 4, 1845.

No. 20.

Extracts from Mr. Rennie's Report on Southwold Harbour.

London, January 6, 1820.

THERE is little doubt that the harbour of Southwold has, at former periods, been of a much greater depth than it now is, as will hereafter be shown; and that, for many years past, it has been getting gradually more shallow, owing to the embankment of the salt marshes, over which the tide used to flow, and the stopping some of the creeks which communicated with the channel of the river Blyth. By these changes the influx of the tide-water has been diminished, and, consequently, the efflux, thereby diminishing the velocity of the current, so that the matter, which formerly was not sufficiently heavy to resist its strength, gradually became so. Thus, not only shingle and sand brought in by the tide, but also alluvial matter, brought down by the freshes of the Blyth, subsided, and gradually lessened the depth of the channel; and this evil continued increasing, until the force of the current became just equal to the removal of what more had a tendency to settle. In this state it will remain until the current is increased by freshes in the river, by high tides, or by heavy gales of wind; these will occasion a change in the channel for a time, but it will return again to the same state, unless the quantity of matter thrown in by the sea is of too heavy a nature to be removed by the power of the land-water, assisted by the returning tide, which, in time, will become consolidated, and must be removed by artificial means.

I have not proofs of actual soundings, to show what was the original state of this harbour, because Collins, in his Coasting Pilot, the best early charts I know, and of which I am in possession of the original edition, published in 1693, gives no chart of this harbour; but I learn from documents in the possession of Mr. Jermyn, who has obligingly favoured me with them, that about 1100 acres of ground, over which the tides used to flow, have been embanked; of these about 550 are ancient embankments, 200 were embanked about 50 years since, 100 in 1780, 100 in 1804, 100 in 1807, and 43 acres in 1818. Some of these enclosures lie at the distance of between five and six miles from the mouth of the harbour, but the greater part of them are at Blythborough, about four miles distant from it; that the average rise of water there is about five feet, and the tides used to cover them about six inches; this, however, was important, because, as the tides continued to flow for about two hours there, after it began to ebb at the mouth of the harbour, the greater body of water returned at the last quarter of ebb, when its scouring effect is the greatest; and, when the small rise of tide here is considered, every inch that can be obtained is the more important.

From the best information I have been able to obtain, good spring tides rise at Southwold Harbour six feet six inches, neaps about four feet six inches, but frequently not more than four feet; thus making an average rise of about five feet six inches, so that the tides at Blythborough rise nearly as much as they do at Southwold; the quantity of surface contained within the present embanked channels of the river Blyth, creeks, and low embanked ground connected with it, as far as I can ascertain, may be about 200 acres, on a part of which the tide may rise five feet on the average; on others, not two feet; perhaps if four feet are taken it will be a full average; and if six inches only are taken as the average height, that the tide formerly flowed over 1100 acres now embanked, the diminished force of the current will be nearly in the proportion of ten to four; this is confirmed by the evidence of John Church, formerly a branch pilot, but now master of a vessel, and who has been about 52 years at sea. He said that about 30 years ago the current of ebb was so strong, that they were obliged to make the vessel fast by cables, and a boat could not pull up the harbour; but that now a vessel could stem the current with a good tow line, and a four-oared boat could row up at any time.

I have been thus particular in stating the evils arising from embanking the marshes, over which the tide used to flow, that I may impress on your minds the necessity of preventing such embankments in future, unless a receptacle is made somewhere else in lieu of the embanked lands; for, unless this is strictly attended to, the harbour will go on getting worse, until it be entirely lost, and I am not aware that any remedy can be substituted for the deprivation of backwater.

APPENDIX.

No. 20 *a.*

No. 20 *a.*

Mr. Walker's Report on Southwold Harbour.

SIR, 23, *Great George-street, August* 25, 1841.

YOUR letter of the 29th October, 1839, informed me that the Commissioners of Southwold Harbour were desirous of my "examining the state of that harbour, and advising on the best means for its improvement."

Having learned that there were no correct plans or sections of the harbour nor of the river Blyth, at the mouth of which the harbour is situated, I wrote to you on the necessity for such, and I had the authority of the Commissioners to send down a surveyor for the purpose of making the survey, plans, and sections.

In March, 1840, Mr. Wright, with Mr. Drane as his assistant, proceeded on the survey; and in consequence of a subsequent arrangement with the River Commissioners, to which you were privy, Mr. Wright was directed to extend his survey so as to include the river up to Bulchamp Lock, $6\frac{3}{4}$ miles from the harbour. This being a work of considerable time and labour, the survey and rough plan and sections were not completed until Midsummer, 1840; and Mr. Wright has since furnished me with his Report, consisting of a detail of facts which have been most useful to me in preparing the following Report; and also with his opinions on the different points, which prove that his attention was not confined to the mechanical part of the survey.

On the 3rd October last, Mr. Drane accompanying me, I visited Southwold, where I attended a meeting of the Harbour Commissioners; the Earl of Stradbroke, chairman; and afterwards, and on the following days, I surveyed the harbour and the river up to Halesworth. In this I was aided by Lieut. Ellis, R.N., harbour master, who rendered me all the assistance in his power. Mr. Drane, and Mr. Sterry, the assistant harbour-master, accompanied me up the river. At Halesworth I had a conference with Mr. Stead, the principal merchant of that place, and the most active of the River Commissioners in harbour and river matters.

Since then I have had two fair copies of the plans and sections made; one copy for the Harbour, the other for the River Commissioners. These will be delivered with this Report, and both Commissions will then be in possession of a document, on the accuracy of which, from Mr. Wright's knowledge and great experience, I think they may depend.

You are aware of the difficulty that has attended every inquiry into the former state of the harbour and river, from there being no plan to refer to previously; and you will, I think, agree with me, that the removal of this difficulty henceforward, is, of itself, an important object gained.

It remains for me now, after stating from my own and Mr. Wright's observations, the leading facts and phenomena of the harbour and river, in their present state, which will also be useful for future reference, to give my opinion of the most eligible course for their improvement.

Southwold.

The town of Southwold, containing a population of about 2000, is situated on the nearest rising ground, north* of the entrance of the river Blyth, and is about half a mile distant from its harbour.

The only manufacture carried on is that of salt, the warehouse and boilers for which, are situated at the head of Salt Creek, or at the lower part of the town. The channel of the river, at the point where it enters the North Sea, nearly at right angles to the general line of the coast,—forms the harbour of Southwold. The direction out of the harbour between the two piers is south-east; the direction across the points of the piers is at right angles to the above, or south-west and north-east. Thus as respects either the coast line, or the direction of the entrance, the piers may be said to be of equal length. Both piers are chiefly of fir-timber, nearly parallel to each other, and 115 feet apart (the width of the entrance) at their outer ends.

Tides.

At the harbour, high-water at full and change, takes place at half-past ten o'clock: the best springs are a few days afterwards, at two o'clock, thus the afternoon spring tides, and these only, are in good day-light throughout the year. The tide of flood in the channel, runs to the southward from half an hour after low-water, to half an hour after high-water; hence the northerly winds raise the tides, and the southerly winds keep them back; but the lift of the tide here, as every where upon this coast, is small

A tide gauge is fixed near the entrance, the bottom, or zero, level with low-water of spring tides. A good spring tide rose $6\frac{1}{2}$ feet above this mark; 2 to 3 feet higher is a very high tide; 8 to 9 feet is therefore the greatest rise of tide above zero on the index; and as some very low tides ebb 1 foot under zero, 10 feet may be taken as the extreme lift of the tide, and 6 feet 6 inches that of an ordinary or average spring tide. Neap tides, which seldom ebbed so low as zero, rose only 3 to 4 feet above it.

The average of 80 tides, taken during the survey, reached 5 feet 3 inches upon the index,† but as the average low-water was above zero on the index, the average lift of all tides would be about 5 feet.

Similar indexes were placed at the same horizontal level at the west end of the south pier; at Blackshore Quay, three-quarters of a mile from the harbour's mouth; at Reydon Quay, one mile and a quarter higher, at Blythburgh Bridge, four miles; and at Bulchamp, the first lock, six miles and three-quarters from the harbour.

An observation was made at all the above points, during the rise of a spring tide, and repeated at a neap tide: in both cases it was found that the water at all the places reached the same horizontal level. Winds would no doubt produce some, but in this narrow river not much effect in sending up or keeping back the flow, but the above observation, that the tide at high-water reaches the same level at all places within its reach, is important, as showing that not much in the way of rise of tide is to be expected from any straightening or widening of the river.

Observations of the same two tides were made at low-water; and it appeared that at dead low-water, the tide at the harbour's mouth ebbed only 1 foot lower than at Bulchamp Lock. Thus the avarage lift of all tides at the latter place may be taken at about 4 feet, that of spring tides $5\frac{1}{2}$ feet, and of extreme tides, upwards of 7 feet.

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* All the bearings are given by compass; the variation is 23° 30′ west.

† These Indexes should be fixed very permanently and preserved very carefully.

The times of high water at different stations up the river, were later than at the harbour as under :—

At Reydon Quay,	2 miles from	the harbour,	25 minutes.
At Blythborough,	4 miles from	ditto,	35 minutes.
At Bulchamp,	6 miles from	ditto,	50 minutes.

Low-water at the Harbour was earlier than

At Reydon,	by	30 minutes.
At Blythborough,	by	70 minutes.
At Bulchamp,	by	120 minutes.

The time of the tides ebbing, is about half an hour longer than that of flood. The current of a spring tide near the harbour continues to run up the river about half an hour after high-water.

The velocity of the ebbing tide towards the inner ends of the piers at the entrance of the harbour, where the width is suddenly contracted by the banks of shingle thrown in by the seas, reached, in places, four miles per hour, at very high tides ; the greatest run out of the harbour being between the second and the third quarter of ebb ; while the flood of the same tide at no time exceeded two miles per hour, the greatest velocity being between the second and third quarter of ebb. Opposite Reydon Quay, the velocity did not at any time exceed two miles ; at Blythburg, the rate was three-quarters of a mile ; and decreased gradually up to Bulchamp Lock.

The greatest velocity of the flood tide at sea, observed by Mr. Drane, at two miles from the shore, was, in springs, three miles, and in neaps, two miles per hour ; the direction of the current, south-west, that of the ebb, north-east, with nearly the same velocity, and both diminishing gradually towards the shore.

Sea-borne vessels not exceeding 200 tons, or drawing above nine feet water, can enter with a spring tide and unload their cargoes, chiefly at Blackshore Quay, which belongs to the Corporation of Southwold, and is three-quarters of a mile from the entrance ; and some few go no higher than Walberswick Quay, which is on the south side, and half a mile lower ; others go to Reydon Quay, two miles from the harbour ; which last place, as will be seen by the sections, vessels of equal draught can reach.

At these quays the cargoes are either landed for the town and neighbourhood, or transferred to wherries, drawing about four feet water : these take the coals and other cargoes up the open river to Bulchamp, and thence by the aid of six locks of 14 feet width, in the river to Halesworth, which is four miles above Bulchamp.

Halesworth has a population of 2,500 to 3,000 ; it is a thriving town ; considered one of the best situated corn markets in the county : its present export is stated at 29,000 quarters, and to be capable of great increase, if the navigation were improved.

Mr. Stead informed me, that at present the uncertainty of the corn getting to market, arising chiefly from the state of the harbour, is very great ; that the detention amounts sometimes to three months. Hence the great desire of the Halesworth merchants for a removal of the obstructions, the greatest of which is undoubtedly the Bar opposite the mouth of the harbour ; and after this, the want of water up to the quays ; for crooked and narrow as the river is at present, the passage from Halesworth to the vessels and up again with coal from the vessels, does not usually occupy more than one day.

The Shoal.

Immediately that the current out of the harbour gets from between the piers, and meets the resistance of the sea water, its velocity is checked ; it spreads out on each side ; and the current, which between the piers was three to four miles per hour, is reduced one half, and its direction being controlled by the winds and tidal current, is uncertain. The sand and shingle, which have been carried in between the piers by the flood current, and deposited where that current slackens, are afterwards by the ebb tide carried out of the harbour and lodged at its mouth, where the effluent current diminishes in velosity, and can carry them no further. This forms the shoal water in front of the entrance.

The Bar.

But, as respects the bar, it is principally caused by the shingle which is moved along the coast by the action of the waves in a southerly or northerly direction, according to the wind ; and which, when it comes round the end of the pier, the force of the ebbing current is not sufficient to drive away, so as to keep clear the harbour's mouth.

As the strongest current out of the harbour is at three-quarter's ebb, when the cross tide upon and near the shore is running from south to north, the combination of the harbour and shore currents takes the direction of east ; in this direction, therefore, there is generally the best water into the harbour ; and the harbour is very seldom, if ever, closed by the bar, when it is formed by the south wind round the south pier ; but, with northerly winds, the harbour is occasionally entirely blocked up for the whole width of the opening, the shingle-bank reaching for many yards within the pier heads, and nearly to the level of the top ; and it remains closed until a change of wind takes place, when a cut has to be made by manual labour.

The current out of the harbour is further checked by a ridge of sand which runs along the coast about 250 yards from the shore. On the north of the entrance this sand is called the " Hayle Sand," and on the south side the " Mill's Knoll Sand." In so far as this sand acts as a breakwater to break the force of heavy seas from the entrance, its tendency is beneficial. The entrance of Southwold is, however, little protected in this way, compared with Yarmouth ; and this is another disadvantage under which Southwold labours.

The bar is the great evil of Southwold harbour, as well from its shifting nature as from the small depth of water over it. It is composed of shingle, which, in this as in many other parts of England, forms the great obstruction to the entrances of harbours. It lines the shore ; and, as the stroke of the waves upon this moveable body is oblique, to the north or to the south, according to the wind, the shingle is moved slowly along in either direction. In northerly winds, the shingle, after the space at the back of the north pier is filled, wraps round the end of the pier and comes in front of the entrance ; and, as the wind continues, more and more is brought round, until a shingle-bank (the bar) is formed, in a crescent shape, nearly quite across the entrance ; and the entrance would be very soon entirely blocked up but for the ebbing current of the river forcing its way to the sea through the shingle. In this case the entrance, or deepest water, must be close to the south pier. This is " the south passage." The operations of southerly winds produce the similar but opposite effect round the

Appendix.
No. 20 *a.*

south pier, and then the passage is necessarily close to the north pier. But the greatest inconvenience is caused by the north and north-west winds, which are prevalent, and come more in the way to prevent the harbour-current from falling in with the tide upon the shore than the southerly winds do. When the wind is directly upon or off the shore, the passage is straight out in the line of the piers, which are then comparatively free of shingle; the bar is then detached from the piers in front of the entrance, with a passage on each side, but in such case the action of the effluent current is weakened by being divided.

The level and direction of the bar are so very variable that, before a vessel of any considerable draught attempts to enter, soundings have to be taken, and she is warped in through the narrow channel. The delay is often very great, and so also must be the danger to a vessel riding off upon a coast which has not the advantage of a roadstead, formed by the sands in front of it, as Yarmouth has. The losses have been numerous; and that the trade should continue as it is, notwithstanding these drawbacks, is proof that there are advantages in some other respects; probably the situation of Halesworth, in respect of the corn-growing country around it, is the principal.

The present revenue of the Commissioners was stated to be about 1100*l.* per annum, and to be rather on the increase.

On reference to the plan, it will be seen that the bar, as given by Mr. Wright, is detached from the piers, and is in no point above the low water of average spring tides (zero on the index); but there were times, during the survey, at which the bar was dry at half ebb. Indeed, the situation and shape of the bar, and the depth of water over it, depending entirely on the direction and strength of the wind, are so variable that it was impossible to take soundings near the mouth of the harbour which could be depended upon as correct for two days together. Before and at the time of my survey the southerly winds had been prevalent, the bar was therefore in front of the entrance, and round the south pier; the only passage, therefore, was close round the north pier.

I think it better to add, by way of Appendix, to which I beg to refer you, the principal evidence I received in respect of the bar, and its present condition, as compared with former times, than to embody it in my Report.

It appears generally agreed that the harbour has not been so frequently blocked up at any time since 1830 as it occasionally was previously to that time; and the very useful work done by order of the Commissioners, under Lieutenant Ellis's direction, of straightening and deepening the channel immediately inside the piers, by cutting through the Bellar, has been instrumental towards this, and towards facilitating the passage of vessels by substituting a straight for a very tortuous channel.

After getting over the bar and between the piers there is now a straight passage up to Blackshore and even Reydon Quay, with nowhere less than 4 feet 6 inches at low water, or 11 feet at high water of spring tides; in most places 2 to 3 feet more; while the bar is still occasionally dry at low water of the same tides; and the entrance is subject to be entirely blocked up by a continuance of northerly winds. The pilots, as will be seen by the Appendix, consider the north-west winds, producing what is called the north-west "swipe," (the sweep of the wave along the shore,) as causing the worst bar of all.

Piers.

The north pier seems to have been repaired at different times, but not to have been lengthened since its first formation; it is close-piled on both sides. The south pier has been lengthened 30 feet: the old head is still visible. This pier is close-piled on the north or harbour side only.

That the distance between the piers, or width of the entrance, is too great for the current to keep clear is very evident; but if its width were no greater than the current would clear, it would be too narrow for a vessel to enter in rough weather. There is a choice of evils; and, on the whole, I do not think that contraction of width would be an improvement to such an extent as to render it, under the circumstances, desirable to take down or remove the present piers; but were a considerable extension in length to place, it would be advisable, both as respects the velocity of the ebbing current on leaving the piers and the quieting the harbour within, to *kant* the ends so as to contract the opening to about 80 feet at the points of the piers.

Extension of Piers.

The opinions on the effect of lengthening the piers are very various, some arguing for the extension of the south pier, others for adding to the north pier, some for the extension of both piers, and others for their entire removal. The last opinion is the farthest from mine of any. The experience of harbours generally is against it, and the reason is evident, for it is by the piers that the stream of the effluent water is kept in the same place and course, and prevented from spreading about and shifting as the waves move the shingle and sand in the one or other direction. The history of this, and of most other rivers, particularly when their power is not great, proves this. We are told and shown that their mouths have been at times some distance on either side of the present situation; and there is little doubt that they, and the Blyth also, would again alter if the piers that now confine them in one direction removed. Without therefore, calling in aid the argument that the piers of Southwold Harbour act as a groyne to stop the shingle and protect the town and coast (which they do), the idea of taking down the piers should be abandoned for the harbour's sake.

I have as little doubt that their extension would do good by confining and directing the current into deeper water, carrying the shingle into a stronger tide, and diminishing the distance between deep water and the river. To produce these effects both piers should, I think, be carried out an equal length. No practicable extent of lengthening would prevent the shingle from collecting at the back of both piers; after the space behind them becomes filled, it will come round and in front, as at present; but as the shingle moves in both directions, depending on the wind, I see no reason why, in this view of the matter, the one pier should be advanced before the other. Suppose both piers extended 50 yards, a prevalence of northerly winds (the north "swipe") would tend to bring the shingle round the end of the north pier, and in front of the entrance; and the south pier, if extended also, would tend to press the out-going current against it, and to keep the harbour open; but if in such a case of winds the north pier only were extended, the current out of the harbour, resisted by the shingle in front, and not confined by a south pier, would take an oblique or southerly direction, and its diminished force would be spread over a greater space upon the shore, which would lessen the depth and therefore be detrimental. The inside of the north or longer pier would also form a lodging place for the shingle brought from the southward in southerly winds, which, if the piers had been of equal length, might have passed round clear of the entrance.

The result would be similar if the south pier alone were extended, with this difference however, that the harbour current, in the latter case, would be in the same direction as the ebbing tide along shore, say northerly, and would fall in with it; whereas, in the former case, it would be opposed to it. It is not improbable that the experience of this evil led to the addition made to the south pier, when the north pier was 10 yards in advance of it.

My opinion then is, that it would be desirable to extend both piers, but that if there be any difference, the south should extend beyond the north one. In the present state of the harbour revenues, I fear that this might be considered an expensive work. From a general estimate I do not think it would be less than 20*l*. per lineal foot of each pier.

Embankments.

On the injurious effects produced by embanking the low land, there is a greater unanimity of opinion, as appears by the evidence which has been transmitted to me, of the captains of vessels and others; and as respects the entrance and the harbour below the embanked part, there can, I think, be no doubt of the fact. If there were no River Blyth nor receptacle for tidal water to pass in and out at every tide, the harbour would cease to exist. The area of the entrance, as respects its width and depth, is the balance of the velocity and quantity of water which passes between the piers on the one side, and of the resistance already referred to on the other. If with the same width between the piers we reduce the quantity of water which has to pass in or out in the same time, we diminish at once the required velocity or power to remove obstructions, and a decrease of depth follows almost immediately. This evil may be counteracted by the formation of piers to confine and direct the current, and by other artificial means, so as to make the smaller quantity do as much good as the larger did before; but with the same improvement of piers the larger quantity would have done more good. It is in this way that the evidence of Masters, taken in 1839, is to be reconciled with that taken by me. The former has regard to the black side only, and to the injurious diminution of velocity from four to one and a half or two miles per hour, in which I fully agree. The latter refers to the state of the entrance generally, to the piers in their present condition, and to the useful straightening and improving of the harbour inside the piers by removing the Bellar Shoal and confining the width.

By Mr. Wright's measurement, of which an abstract is given in the Appendix, showing the area and level in each division, it appears that the whole area within his survey, formerly overflowed by the tidal waters of the River Blyth, was at every spring tide nearly 2000 acres, exclusive of the Dingle, Westwood, and Dunwich marshes, about 1200 acres of which are considerably below the level of a spring tide; and as they had no other outlet, should be considered as having formed part of the old estuary of the river or backwater of the harbour. By the embankments this area of 2000 acres is reduced to 450 acres, the area from which the tide is excluded being thus 1550 acres. Over a portion of this the depth would be small even at spring tides, but over more than half the area it would exceed two feet, and in cases of very high tides and land freshes, double this or four feet. The last large enclosure was that of Bulchamp new Saltings, 105 acres, in 1804, the level of which is three feet under an average spring tide. The deduction from the quantity of backwater is not confined to what is actually embanked, for the reduction of the estuary by stilling the water upon the space between the present river banks and the channel of the river allows that part to silt up, so that its level is now up to the high-water of spring tides, or several feet above the reclaimed ground within the banks. While the injury done to the entrance of the harbour and to the harbour itself is certain, it may be that the river opposite the embanked parts is not injured, but, on the contrary, improved; this is the case generally where the river depends more upon the land than the tidal waters, by confining the width and thus increasing the scour. In this instance, where the land water is small, I do not consider the river improvement, effected in this last way, as by any means equal to the injury done to the harbour.

It is to be lamented that when the owners of estates were perhaps balancing in their minds whether the land they could reclaim would pay the expense of reclaiming it, they were not advised of the injury they were about to do to the public and themselves by the reduction of the backwater, upon which their harbour is dependent; this would probably have decided the question and prevented the execution of the work without other interference. That many harbours have thus suffered through ignorance or neglect, at least as much as through the desire to obtain property, is probable. In the present case, to destroy the banks of the parties who have been allowed to exclude the water—some upwards of a century, none it appears less than 36 years—and who have been, perhaps, at great expense in draining and improving the surface, would, even if lawful, be such a hardship, and would be so opposed on its own account and as a precedent, that I apprehend this is practically out of the question. The same principle, applied in its full extent, would lead to the removal of the locks, which also exclude a portion of tidal water. It would be much better, I think, to take these encroachments as having the sanction of time, and to consider what is best under existing circumstances, taking care however to prevent the further reduction of the backwater; and the present question is what, if anything, can be done for improving the harbour or the navigation upwards in the way of substitute for the reclaimed land or generally.

I have already referred to the extension of the piers, and I know no surer way to improve the entrance of the harbour than by reducing its greatest evil—the bar. On principle it is correct, and in most other cases has been successful. Would the proprietors of land assist in this? Although they may not at first sight feel so interested in this as the merchants do, a little consideration will show, I think, that they are more so; as in the price which the merchant gives the farmer for his corn, he considers and deducts for the risk and probable delay, and he adds to the price which both landlord and farmer have to pay for their coals and merchandize. Without knowing the fact, I should expect that the same quality of corn in a market as near the entrance of Yarmouth Harbour as Halesworth is near Southwold, will fetch a better price; and if the Southwold quantity be calculated at the difference, the sum may probably amount to much more than the landed interest would be expected to contribute to improve the harbour; a portion they might, and on the score of justice the owners of the reclaimed land might be expected to be the first to come forward.

Deepening and Dredging of Rivers.

After this, the deepening and improving of the river and creeks is the most feasible, and in this the owners of the low lands, liable to be injured by winter floods, are peculiarly interested; as whatever improves the navigation in this way, improves the main drain of the country, and takes off the land floods more rapidly.

APPENDIX.

No. 20 *a.*

There is, I understand, some questions as to boundary between the districts of the Harbour and River Commissions. Any doubt of this kind should not stand in the way of improvement, as their interests are almost identical. The dredging done by Lieutenant Ellis did not reach higher than Blackshore Quay; and in the whole of this length, from the inside of the piers to this quay, and above this to Reydon Quay, there is everywhere, except at the Ferry Shoal, at least six feet at low-water. From Reydon Quay to Blythborough Flats, a length of one mile and a half, the depth is at least five feet at low and eleven feet at high-water: there, therefore, little is required. It has been proposed to cut a straight course through the bend at Blacksand Reach, which I am not disposed, at least under present circumstances, to recommend, as its tendency will be still further to diminish the backwater, by allowing the present channel, which is longer and wider than the new one, to silt up. Indeed, although there are several similar bends up to Blythborough Bridge, I would recommend that the present course generally be deepened and widened; the very sharp angles and points cut off; and the steep banks sloped back, in preference to new cuts. A bottom width of 30 feet, and a depth of at least 6 feet at the high-water of neap tides up to Bulchamp Lock, would give great facility, and at a comparatively moderate expense.

Blythborough Bridge.

Blythborough Bridge, in the line of the turnpike road, is a great nuisance; the whole height between the soffit of the arch and the ground is only 10 feet: when a spring tide is in, there is only 4 feet above the water; and at the high-water of a neap tide only 4 feet of water. It is a disgrace to the navigation and the county, and ought not to be tolerated another year. I can only suppose that it is owing to some mixed interests, and consequent want of understanding, that it has been left so long. A cast-iron flat arch, of 35 or 40 feet span, would, I apprehend, be sufficient.

If the river generally were deepened, the sill and chamber of Bulchamp Lock should be lowered. At present, there is only 5 feet over it at high-water of spring tides, or 4 feet at neaps, when the wherries drawing 4 feet can enter only at the top of the tide.

Salt Creek for Basin, &c.

The next and last improvement I would name, is the enlarging and deepening of Salt Creek up to the town of Southwold, although I fear it may be some time before this is accomplished. I have seldom seen so good an opportunity of making a snug basin as this presents, if the trade of Southwold would afford it. At the same time, by means of a pair of gates on the balance principle, or even common gates with sluices, a very useful addition might be made to the back-water, for the benefit of the entrance to the harbour. The water would all be let out at the best time of the ebbing tide, when the effect, from its proximity to the entrance, would be considerable.

My opinion finally is, that although Southwold will never be a very important harbour, it is capable of improvements which would much increase the trade of Southwold and Halesworth, and the value of all the property, of which the harbour is the outlet; and that the first step towards this is a perfect understanding between the Harbour and River Commissioners. There may be reasons, of which I am not aware, that prevent the two forming one Commission, but I am sure that the interests are almost the same.

I am, Sir,
Yours most obediently,
JAMES WALKER.

To Harry White, Esq.,
Clerk to the Commissioners of Southwold Harbour, &c.

TABLE, showing the Area of the Embanked Lands, formerly overflowed by the tidal waters of the River Blyth; with their Situation, and Level below a 6-feet 6-inch spring tide; and the Quantity of Backwater excluded thereby from scouring the Harbour.

Parish in which situated.	No. of Acres reclaimed, including walls, &c.	Average level below a tide of 6½ feet.	Cubic feet of water excluded.
	Acres.	Ft. in.	Cubic ft.
Southwold	171	3 3	24,208,470
„ New Marshes	36	0 6	784,080
Reydon (from Wolsey Creek)	254	3 6	38,470,840
Reydon with Easton	94	1 9	7,165,620
Walberswick	79	2 6	8,603,100
„	146	1 9	11,129,580
Blythborough, east of bridge	83	2 0	7,230,960
„ west of ditto	72	1 0	3,136,320
Bulchamp	150	2 3	14,701,500
„	105	3 0	13,721,400
„ N.E. of Blythburgh	80	2 6	8,712,000
„ N.W. of ditto	86	1 9	6,555,780
„ at Bulchamp	58	0 6	1,263,240
„ south side of river	60	0 9	1,960,200
Wenhaston	30	0 6	653,400
	1,504		148,296,490
Dunwich, Westwood, and Dingle Marshes	1,200		
	2,704		

No. 21.

Report on Southwold Harbour and the River Blyth, by an Admiralty Surveyor on the East Coast of England, to the Secretary of the Admiralty.

SIR, *H. M. S. Blazer, Harwich, August* 1, 1844.

Admiralty Orders.

IN obedience to their Lordship's directions, to report on the past and present condition of Southwold Harbour, I have the honour to state that, having given notice of my intention to Lieutenant Ellis, Harbour Surveyor, and to the authorities, on the 8th July last I proceeded to Southwold, where I met several of the Harbour Commissioners, the Harbour Surveyor, Mr. Stead, merchant of Halesworth, with the steward and agent of Lord Stradbroke and Sir Charles Blois, the two principal landed proprietors on the banks of the river Blyth; and in their presence I took the evidence of the old pilots, masters of vessels, and wherry or lightermen, as to the former and present state of the harbour and bar.

Evidence of pilots, &c. at Southwold.

Map of River Blyth.

I was furnished with a copy of Mr. Wright's large map of the river Blyth, on the scale of 20 inches to a mile, made for Mr. Walker's survey in 1840; a valuable document, highly creditable to the surveyor who executed it, and to the public spirit and liberality of the Harbour and River Commissioners, at whose joint expense it was made. This plan greatly facilitated my inquiries, and in all future proposals for the improvement of the harbour it will be found of the greatest utility. A reduced copy of it accompanies this report.

On the following morning, in company with Mr. Calver, master and assistant-surveyor of the *Blazer*, Lieutenant Ellis, R.N., and Mr. Stead, one of the river commissioners, I examined the bar, the harbour, and piers, and rowed up the river Blyth as far as the Bulchamp Lock, a distance of about five miles and a half.

Evidence of wherrymen, &c.

At Blythborough Bridge I met Mr. Johnston, banker of Halesworth, and Colonel Bence, usually Chairman of the Harbour Committee of Management, also river commissioners, and received the evidence of other wherrymen and navigators employed on the river, as well as that of Mr. Stead's agent.

Acts of Parliament, Reports, &c.

Since my return I have read all former reports on the river and harbour, from the survey of Mr. Langley Edwards, in 1757, to that of Mr. James Walker, in 1841; also the five Acts of Parliament relative to the harbour, and the evidence taken before the Commissioners in 1839; all of which has been readily furnished to me by Mr. Stead and Lieutenant Ellis, from both of which gentlemen I have derived the greatest assistance in the course of my inquiry.

I am thus particular in stating my authorities, in order to show that, whatever opinions I may offer, though they may be erroneous, have not been formed without ascertaining the facts that appeared to me to bear on the question, nor without hearing what those who are most interested or best qualified had to say on the subject.

River Blyth.

The river Blyth has its chief sources in the parish of Rumburgh, to the north-west, and of Laxfield to the south-west, in the north-eastern part of Suffolk. Receiving in its course six tributary streamlets, it flows in a general easterly direction, chiefly through a narrow diluvial valley, averaging half a mile wide, and falls into the North Sea at Southwold. The outer or sea-reach of the river, which for the last mile of its course now runs nearly straight in a south-east direction, forms the harbour, and communicates with the sea between piers of timber placed at right angles to the general line of coast, and beyond which they project about 100 yards. The width of entrance is 115 feet.

The tract of country drained by the Blyth is of the tertiary formation (provincially termed "Norwich Crag"), and has no eminences of any importance. It may be 50 square miles in extent, and the volume of fresh water carried down by the stream, even in freshes, is insignificant.

The river is navigable at tide time for vessels of about 200 tons as far as Reydon Quay, at 1½ miles from its entrance; then by wherries or barges 4 miles farther up to Bulchamp Lock; and thence again by means of six locks (through which in the course of 4 miles there is an ascent of 27 feet) to the thriving town of Halesworth, one of the chief corn markets of the country.

Southwold Road.

Southwold Road, more familiarly known as Sole Bay, has good anchorage in offshore winds in 5 and 6 fathoms at the distance of half a mile, and 3 fathoms at a quarter of a mile from the coast. The depth then gradually shoalens towards the beach till within 250 yards of the piers, where a ridge called the "Sand Haile," or "Mill's Knoll" (thrown up by the offscour of the beach, or by the stroke of the sea at its first break in heavy easterly gales), extends along parallel to the coast, having on it a depth of only 6 feet. Between this and the shore the water again deepens to 12 and 15 feet, until we approach the "Harbour Shoal," a sandy flat, caused by the meeting of the outset of the river with the coast stream; and on this, as a base, a shingle bar rests, usually in a crescent-like form, but varying in shape and height, according to the prevalent winds.

Tides.

From observations made by the Harbour Surveyor, and also during Mr. Wright's survey, it appears that the *time* of high water, at full and change of the moon, is as follows:—

	H.	M.
At Southwold pier heads	at 10	15
At Reydon Quay (at 1½ miles)	at 10	40
At Blythborough Bridge (4 miles from pier)	at 10	50
At Bulchamp Lock (at 5½ miles)	at 11	5

or 50 minutes later than at the harbour's mouth.

From similar observations on the tide-scale at the entrance of the harbour (the *zero* of which is said to be on a level with the average low-water springs), we have for *range*—

A good spring tide	6½ feet	Average neaps	3½ feet
An equinoctial spring	9	Average of 80 tides taken during Mr. Wright's survey	5 feet
Greatest range observed	10		

From a fortnight's observations made by the coast-guard in June, 1834,* and June, 1835 (perhaps the least favourable month of the year), it appears that the

	Feet.	In.		Feet.	In.		Feet.	In.
Greatest range was	7	2	and	6	5	giving the mean	6	9½
Least range	4	6		2	10		3	8

or a greater range in those two months than at Yarmouth, Corton, Lowestoft, or Kessingland.

* Philosophical Transactions.—Mr. Whewell on Tides.

APPENDIX.
No. 21.

It has also been found, by careful observations, that the tide at high water reaches the same horizontal level at all places along the river, as far as Bulchamp Lock; and that low water at the harbour's mouth is only 1 foot lower than at the same Lock.

Rate of tide.

The rate of tide within the harbour averages 2 knots, gradually decreasing up to the first lock. Occasionally, when the channel is much narrowed in its limits by shingle or otherwise near the inner ends of the piers, it is said to run from 3 to 4 knots an hour. In the offing the rate of the tide seldom exceeds 2 knots; the ebb stream setting to the north-east, and the flood to the south-west, and running respectively rather more than half an hour after low and high water by the shore.

As Southwold is a place entirely dependent upon tidal waters for existence as a harbour, the above details of the tides, although rather tedious, seemed absolutely necessary, We may now proceed to consider the past and present state of the port.

No old plans.

We have no proof from actual soundings of the original depth of Southwold Harbour. Greenvile Collins, who, by direction of Charles II., surveyed this coast in 1682, gives no chart of it in his "Coasting Pilot;" but it seems to be admitted on all sides, that at former periods there was a fair depth of water in the harbour. In the plan of Isaac Johnson of Woodbridge, who surveyed the river in 1806, there is, with the exception of the Flats, a depth of from 7 to 8 feet, when reduced to low-water springs. In Mr. Wright's survey in 1840 there is a general depth of 6 feet at least, as far up as Reydon Quay.

So far from documents. On turning to the evidence, we find that, however conflicting that of the old pilots, &c., is (and it is sufficiently so), there are two points on which all are agreed—namely, as to the gradual deterioration of the harbour, and its bad state down to the year 1833; and the great improvements, under the present Harbour Surveyor, by dredging the channel,* by cutting through the "Bellar Shoal," and by straightening the lower course of the river.

They are also unanimous that, in spite of these improvements, the bar is still very bad; and the majority agree in attributing this to the embanking of certain marsh lands in the upper part of the river, whereby a quantity of tidal water has been excluded, and the velocity of the stream materially diminished.

Extent of embankments.

What, then, is the nature and extent of these embankments? On reference to the accompanying plan, it will be seen that the whole area formerly overflowed by the tidal waters of the river Blyth was, at every spring tide, about 2000 acres, exclusive of the Dingle, Westwood, and Dunwich Marshes, about 1200 acres of which are also considerably below the level of a similar tide. By the various embankments (tinted green on the plan), this area of 2000 acres is reduced to 450 acres, the presen water surface at high tide; the area, then, from which the tide is excluded amounts to 1550 acres.

Now, it has been shown that the high-water tide at Bulchamp Lock reaches the same horizontal level as at the harbour's mouth; over more than half this area, then, the depth at high water, ordinary springs would exceed 2 feet; in the event of high spring tides it would be 4 feet; and in north-west gales, or equinoctial springs, fully 6 feet. We have thus the means of calculating roughly the quantity of water excluded by these embankments; and, taking this at the lowest estimate—that is, at a common spring tide—it gives us in round numbers 150,000,000 cubic feet of water. Now, about three such tides occur at each spring or 78 a year; from which some notion may be formed of the enormous loss of scouring power sustained in consequence of the embankments in question.

No notice is here taken of the 1200 acres of Dunwich Marshes, nor any allowance made for extreme tides, which would probably more than double this amount, and far more more than double its power; for it must be borne in mind that the injury done by any diminution of the power or head of water which scours a river and removes obstructions, is not simply in proportion to the quantity excluded; it increases in a much greater ratio. Besides the actual exclusion of tidal water, and formation of foreshore common to all embankments, all encroachments on the area of a river are mischievous, from the stilling effects on the wash of the waves for want of space; as this wash helps materially in maintaining a general depth.

Act 46 Geo. III. c. 153.

Such, then, appear to be the nature and extent of the embankments in the river Blyth. Now, by the decision of the Judges, founded upon *Magna Charta*, and all statute law, "all land subject to the flux and reflux of the sea and the soil of all navigable rivers in England belongs to the Crown:"—the above mentioned marshes therefore are Crown Lands.

By the same decision of the Judges, "no length of time can legitimize such encroachments;" nor have they been authorized by any grant of the Crown or by any Act of Parliament: the embankments therefore are illegal.

Their immediate prejudicial effects to navigation are visible in a bad bar and a sluggish stream.

Now it may be contended that the improvements in the harbour, or lower part of the river, fully compensate for the tidal water embanked out in the upper part of the Blyth; but even supposing that they did so, which I cannot for a moment admit, why should Southwold, more than any other port, be deprived of the scanty advantages bestowed upon her by nature, and not rather have them jealously guarded with the utmost care, and in addition to them have all the improvements that artificial means, directed by a skilful Harbour Surveyor, can bring to her aid. Had the port, besides the deepening of the lower part of the river, had the advantage of the above-mentioned 150 millions of cubic feet of water scouring to and fro 78 times a-year, who can doubt but that the bar might have been kept down to a moderate height as at Yarmouth, and other ports along the coast. For it must never be forgotten

Depth due to tidal water.

(which is indeed received as an axiom by all engineers), that the depth of water in a port or the lower part of a river is not due to backwater or freshes, but to the amount of tidal water that daily passes to and fro. Compare for a moment the fresh water brought down by the Blyth, with the volume of tidal water that it daily receives even in its now contracted dimensions, and see how utterly insignificant is the stream; how much greater, then, would have been that disproportion, if the whole surface of the 1500 acres now embanked had been permitted through the medium of a well dredged and straightened entrance to be covered at every spring tide.

It does not appear from any documents that I have been furnished with, that the proprietors of the embanked lands along the margin of the river have paid anything towards the improvement of the harbour, but that this expense has been defrayed entirely out of the Southwold port dues; now, who

* It appears by Mr. Stead's letters to the Southwold Commissioners that he had repeatedly urged the necessity of dredging the harbour.

pay these dues? From the papers before me, it seems that they have been chiefly paid by the merchants of Halesworth, who ship their corn and malt, and import their coals, &c. (when the bar will allow them to do so), through this harbour; they, therefore, have a right to claim that no obstruction shall be offered to the free influx of the tide in a river in which they are so deeply interested.

Value of lands.

Of the present value of the reclaimed lands, or of the cost of the embankments, I have no means of judging; but one of the Harbour Commissioners, who proposed a few years ago to reclaim Buss Creek, estimates the probable yearly value of that land at 3*l.* an acre; but if we may assume half this price, (which is most likely much nearer the truth), the 1500 embanked acres would yield upwards of 2000*l.* a-year; and although I think they are most to blame who first permitted these encroachments, still it would seem but reasonable and just to expect those who now derive such a benefit from lands to which, it appears by the before mentioned decision of the judges, they have no legal title, to expend a portion of it for a few years in deepening the bed of the river, in order to compensate in some measure in depth for the extent of surface of which their predecessors have been instrumental in depriving it. But this is a point I leave for their Lordships' decision.

Improvements suggested.

It is the province of an engineer to point out the proper remedy for the damage which has hence arisen to the harbour, but the more obvious mode of proceeding would seem to be—

1st. To dredge the river to a uniform depth throughout, and widen it till its channel contains a reservoir for tidal waters equal to that of which it has been deprived. To cut off the sharp angles; but not by any means otherwise to straighten its course, as the bends of a river are advantageous to it in some respects. This deepening of the channel, besides being of advantage to navigation, would greatly benefit the low lands of the country, as it would materially improve their drainage.

To deepen the bed of river.

2nd. To carry out the piers into deep water—say 12 feet at low-water springs; to curve them slightly to the eastward, till the outer ends approach each other to within 80 feet; and to open out to the E.N.E. instead of to the S.E., as at present.*

To extend the piers.

One evil of the actual piers is their width of entrance; and although 115 feet seems little enough opening for a ship to enter and to allow the tide to fill the estuary above, yet, when we see that the back water, owing to its great reduction, can only keep a channel open of half that width, we must follow in the track pointed out by nature, and diminish accordingly.

By carrying the piers out about 100 yards into deep water, the pier-heads will be in the strength of the coast current; and if we curve them so as to open out in an E.N.E. direction, it will cause the outset of the harbour to harmonize with the ebb stream along the coast, instead of meeting it at right angles, as at present.

Groynes recommended.

And if in addition firm wooden groynes were run out along the coast, at short distances, to the east and west of the piers, it would be a long time before any shingle bar would form sufficient to damage the entrance. That the opening to the E.N.E would cause a quantity of sand and shingle, and swell, from time to time to be washed into the harbour in north-easterly gales, I admit, but this is a much less evil than having an impassable bar at its mouth: and Salt Creek would form an admirably sheltered basin for vessels to lie in, free from swell, at little expense for dredging.

Capable of improvement.

In conclusion, I fully agree with Mr. James Walker, and all engineers who have examined it, that although Southwold will never be a very important harbour, and certainly not a "harbour of refuge," it is capable of improvement, which would much increase the trade of Southwold and Halesworth, and the value of all the property of which this harbour ought to be the legitimate and natural outlet.

I am, &c.,
JOHN WASHINGTON, *Captain.*

To the Secretary of the Admiralty.

No. 22.

Opinion of Mr. Rendel, Civil Engineer, on Embankments of Rivers.—(Referred to in Q. 1865.)

Suppose a river to be reduced in its surface by cutting off pools and openings, (but retaining the same amount of land waters,) straightening the banks, thus increasing the velocity, scouring the river of banks of mud:—

I. Will the tide run higher up the river?

It will.

II. If it should do so, will that be from greater velocity of tide? III. Or, from the tide running by a shorter course, it necessarily runs higher up?

To both in a degree:—to the former indirectly, and to the latter directly.

IV. Or, by being confined by the banks, it runs higher up before it can find its level?

Its momentum is increased by the uniformity of its banks and bed; and hence it makes the time of high water earlier in every part of the river above, and rises proportionably to a higher level.

V. Suppose any or all these results: will the effect be advantageous or injurious to a bar at the mouth of the river?

The effect will be advantageous to the bar, by the greater momentum with which the scour of the land and tidal waters is returned on their ebb.

VI. Will the bed of the river be deepened by the process described?

It will, if the soil is of the ordinary kind found in the valleys of large rivers, and it is to the increased depth and the uniformity of current over the whole width of the channel by the removal of banks and side and bottom eddies, that the same rise of tide at the harbour's mouth causes it to flow further up the country, and to rise to a higher level. Depth is no less important to the momentum with which the water ascends and descends than to the convenience of the navigation.

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* A plan showing the probable effect of such a position of the piers has been drawn by Mr. E. K. Calver, Master of Her Majesty's ship *Blazer*, and with a Report embodying his opinion on the case, has been sent to the Southwold Commissioners. A copy of it is in possession of the Tidal Harbours Commission.

APPENDIX.

No. 23.

No. 23.

Report of an Admiralty Surveyor on the East Coast of England, on the Port of Harwich.

Woolwich, January 19, 1843.

Harwich a port of refuge.

THE port of Harwich, owing to its general depth of water, its extent, the shelter it affords, and its immediate communication with the sea, is one of the most valuable on our eastern shores; and although the rivers Thames and Humber afford shelter by running far up them, yet Harwich, from its easy access by night or by day, in all weathers, and in all states of the tide, is the only harbour of refuge, properly so called, on the East coast of England.

Memorial of mayor.

The memorial of the Mayor and other inhabitants of the borough of Harwich states, that in this harbour, which in easterly gales has given shelter to 500 sail of shipping at once, great changes have taken place within the last 20 years, owing to the falling down and washing away of Beacon Cliff on the western side of the entrance, and the growing out of Landguard Point on the eastern side, whereby the harbour is already much deteriorated, and is daily becoming worse.

To the truth of this statement I can bear the fullest testimony from my own observations during the last two years, and all the evidence I can obtain, goes to show that the sole and immediate cause of the damage in question is, the digging up and carrying away the cement stone from the foot of Beacon Cliff, and Felixstow Ledge.

Loss of Beacon Cliff.

From the unanimous testimony of the older inhabitants of Harwich, it appears that Beacon Cliff (which is chiefly composed of Blue or London clay, with layers of *Septaria* or Cement stone), has fallen away much more rapidly within the last 25 years than it did at any previous time; but not feeling quite satisfied with this evidence, I have procured plans of the town and cliff for the years 1709, 1756, and 1804, and have transferred the high and low water lines for these several periods to the plan of Harwich, completed last year in Her Majesty's ship *Shearwater*. From which it appears that in the first half century less than 40 feet, or not a foot a year, of the cliff was washed away; in the second half century about 80 feet went to sea; while during the last 37 years the sea has advanced in a direct line upon the land not less than 350 feet; and the beach at the foot of the cliff has been so much lowered that the low water line, during this short period, has gained 600 feet upon the shore; thus presenting on the western side a greater surface of water, whereby the scouring effect of the flood and ebb streams in keeping the channel clear is much weakened; a barrier that tended to shoot the ebb tide over against Landguard Point is removed; full 40 acres of ordnance, glebe, and manor land, of excellent pasturage, with tenements and other property, have been swept away, and the harbour deprived of an invaluable breakwater in southerly and south-westerly gales.

Evidence from old plans.

Traffic in cement stone.

Now, the traffic in cement stone began about the year 1812, or 30 years ago, since which period, I am credibly informed, that upwards of a million of tons of this stone have been carried away from the shores in question. This fact, combined with the evidence derived from the plans, seems conclusive as to the cause of the encroachments of the sea upon Beacon Cliff.

Extension of Landguard Point.

But while the sea has gained upon the land on the western side of the harbour, the contrary has taken place on the eastern or Suffolk side, where within the last 30 years Landguard Point has grown out 1,500 feet, thereby blocking up the chief entrance into the harbour; so that where in the year 1804 was a channel seven fathoms deep at low water, is now a shingle beach as many feet above high-water mark.

Felixstow Ledge.

This mischief has been accelerated by carrying away the cement stone from the foot of Felixstow Cliff, about two and a-half miles to the north-eastward, where it formed a rocky projecting ledge which served as a breakwater, for the whole of this shore, from the force of the sea in north-easterly gales. But since this stone has been removed (to an extent of 200,000 tons I am told), a large slice from Felixstow Cliff has gone into the sea, two mortella towers and a small battery, only built in 1808, have been swept away, and the beach of Landguard Point has grown out, as above stated, to the extent of 500 yards, in consequence of which the two lighthouses, erected but a few years since at a great expense, are no longer a safe leading mark into the harbour; on the contrary, they have already caused serious damage to several vessels by running them ashore.

These are great and increasing evils, and demand immediate attention, if the port of Harwich is to be preserved.

Remedy recommended.

It is the province of an engineer to point out the proper remedy to take, but the more obvious measure would seem to be to put an immediate stop to the daily practice of carrying away cement stone from the foot of the cliffs, and to replace by an inexpensive breakwater of rough stone run out about 800 yards, the natural barrier which has been carried away from the foot of Beacon Cliff, whereby the ebb stream will be again directed against Landguard Point, so as to prevent its extension, and the shelter to the outer part of the harbour in northerly and southerly gales will be restored.

Of the large quantity of cement stone that has been carried away from under Beacon Cliff, I am informed that 200,000 tons have been taken by the Board of Ordnance, and applied to Government uses.* If such is the case, perhaps it might not be considered as expecting too much to call upon that Board to protect the cliff from further encroachments, and to replace by groynes, or other artificial means, the natural breakwater that they have been instrumental in causing to crumble into the sea, and thereby most seriously damaging the harbonr.

A pile jetty recommended,

Mr. Walker and Mr. Rendel have recommended a pile jetty along the northern face of the town, in which I fully agree; but the interests of navigation require that some care should be bestowed in preserving and improving the present channel into the harbour. Since the deep water entrance by Landguard Point is lost (certainly for some time to come,) the actual channels should be dredged so as to command a depth of 15 feet at low water, or 27 feet at high-water springs; this would be attended with little expense, as the dredgers now on the spot would gladly undertake the work for a bounty of 1*s.* a ton on all the cement stone taken away from the different shoals in the harbour, and there would be no difficulty in pointing where and how this might be done to the greatest advantage.†

Dredging proposed.

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* The Ordnance have had a cement mill at Harwich, since the year 1818, let the greater part of the time for 500*l.* a-year, and now at 300*l.* a-year.

† The Admiralty have since granted 100*l.* for this purpose; besides which the Corporation of the borough of Harwich have liberally expended a similar sum, with which 520 tons of soil were dredged up, 70 tons of this were of cement stone, worth 5*s.* a ton.

A small red harbour light would also be required to be placed about 25 yards to the southward of the present low light, to obviate the mischief now of daily occurrence, in consequence of the two lights in one being no longer a safe leading mark to clear Landguard Point. The harbour buoys might also be much more advantageously placed than at present,* and two or three small beacons would be required; but the greatest improvement to the navigation of this part of the coast would be a small floating light near the entrance of the harbour, and a fixed light at the tower of Walton-on-the-Naze. Improvements in surveying.

The above recommendations are suggested not only by the increasing trade of the ports of Ipswich, and Manningtree, of which Harwich is the outlet, and by the extent of the Government property in the town, but more especially by the present value of this harbour as affording shelter to the vast body of shipping that daily pass along the east coast of England in winter as well as summer, and the facility with which assistance is rendered from this port to vessels wrecked on the Shipwash to the north-east, and the West Rocks, and Gunfleet Sand to the south-east, perhaps the most dangerous sands in these seas. Increasing trade. It is well to bear in mind what this port was during the last war, and what it must again become for another North Sea fleet. It was from Harwich that the Hollesley Bay fleet was always watered by transports; it was here that all vessels, from a frigate downwards, in case of need came for a partial refit at the naval yard still in existence; here not less than 60 ships of war have been built, 15 of which were two-deckers, while the tonnage of the vessels employed in the North Sea Fishery belonging to Harwich, a few years since, was estimated at 3000 tons, employing 500 hardy seamen. Hollesley Bay, fleet watered here. North Sea Fishery.

These considerations alone would more than justify any small outlay to preserve this port from further damage, but in addition it should be remembered that this may shortly become the packet station for all our mail communications with northern and central Europe, that as soon as the railroad, already open to Colchester, is completed to Harwich, letters dispatched from the General Post-office might be delivered in three hours direct on board the Mail Steam Packet lying waiting alongside the pier,—that passengers could walk on board, and in less than a quarter of an hour be clear out at sea, in all weathers and at all times of tide, and 60 miles ahead, even in fine weather, of those mailed at the same time in London, which would probably make the difference of a whole tide in arriving off Ostend or the Brielle, or other bar harbours, while in north-easterly gales and fogs steamers would often make their passage before those starting from London could get clear of the shoals and currents of the deep gulf which forms the estuary of the Thames: in proof of which 28 steamers, carrying mails, in spite of strict orders to the contrary, have been compelled to put into this port for fuel, or to land their mails, after contending for upwards of 24 hours against strong head-winds, which prevented their making their voyage. Probable mail station. Steamers put in for fuel.

Under these points of view, then, but chiefly as the Packet Station for all northern and central Europe, (thereby avoiding the less expeditious and less secure transit through France,) the preservation of this port appears to be of national importance.

JOHN WASHINGTON,
Captain of Her Majesty's Ship "Shearwater."

To the Secretary of the Admiralty.

No. 24.

Report of an Admiralty Surveyor on the East Coast of England on the Port of Whitby; with some Notes on Scarborough, Filey Bay, and Bridlington.

H. M. S. Blazer, Whitby Road,
October 12, 1844.

SIR,

IN compliance with your general instructions, to lose no opportunity of examining and reporting upon every port which in the course of our survey we may chance to visit, I beg to acquaint you that, having learnt at Scarborough that Mr. James Walker, C.E., was to be at Whitby this morning, we weighed from that Bay at daylight and ran down here, where we are at anchor in the Road, in 9 fathoms water, good holding ground, about half a mile from the pier end. The outer point of the Whitby Scar bearing S.E., the northern extreme of land N.N.W., and thus it affords good shelter to the coasting trade in all southerly and westerly gales.

On landing, I met Mr. Walker; his assistant, Mr. Comrie, who had been engaged for some time in making a plan of the harbour and the entrance; Lieutenant Brittain, R.N., of the Coast Guard, who has been here 10 years, and appears a seamanlike, intelligent officer, and well acquainted with the port; Mr. F. Pickernell, the resident engineer; and Mr. Clarke, the harbour-master; and walked with them round the piers, and examined the harbour.

A stranger's first impression, on setting his foot on the west pier, must be that of admiration at its bold dimensions, both in width and length, and its beautiful structure of the well-known Whitby stone. The picturesque valley of the Esk,—the defined outline of the pier and lighthouse,—and the ruins of the far-famed Abbey on the cliff above,—form a striking scene.

On turning to the harbour, a sailor is struck by the contrast: with the exception of the small stream of the Esk, the harbour is dry at low water, and its entrance and sides encumbered by sands; even the light boat in which I landed was obliged to push outside the piers to remain afloat, and the bar dries 4 feet at low-water springs.

Having the advantage of a tide ranging 15½ feet on average springs, 17 feet on good springs, and 20 feet on equinoctial springs, or in a N.W. gale, there does not, at first sight, seem sufficient reason for the bad state of the Bar and this accumulation of sand; but a little inquiry as to the state of the upper part of the river, and an attentive consideration of the relative length and position of the piers, and the width of entrance, will, I think, account for much of the evil.

The latter, however, are rather engineering questions, into which I do not feel qualified to enter; but I may state that it is the opinion of the officer of the coast guard, who has resided 10 years on the spot, has watched vessels entering in all weathers, and seen many wrecked on the Scar behind the east pier—

* These alterations have since been made by the Trinity Board, with the invaluable addition of a light vessel placed near the entrance of the harbour.

APPENDIX. No. 24.

1st. That the width of entrance (300 feet) is one-third too great.
2nd. That the east pier should be carried out to cover the Scar to the same length as the present west pier.
3rd. That the piers, instead of running out in a N.N.E direction, as at present, should have been carried out in a north or N. b W. direction, fair with the lower reach of the river. This, too, would have given greater shelter in N.E. gales—the worst on this coast—and have prevented much of the swell that tumbles into the harbour.
Lastly. That the billet head of the west pier should have been a fiddle head (to use a sailor's phrase) or turned the other way.

As far as a short visit will enable me to judge, I confess that I agree with these remarks:—1st. If it were quite certain that ample room would be left for the entrance of the tidal water, so as completely to fill the channel above, I would, under the peculiar circumstances of the case venture to recommend the narrowing the entrance even to 180 feet.

2nd. This narrowing would, I think, be best effected by extending the east pier in a north, or perhaps in a N. ½ E. direction, to the same length as the west pier; and, with every deference to engineers, I should be disposed, in so doing, to curve it very slightly, convexing to seaward; for, as I stood on the pier at low water and watched the puny efforts of the river stream struggling to make its way out, I observed that it naturally curved, as all rivers do, and formed the deepest channel in the bight: this curve would also have the advantage of directing the outset of the ebb to harmonize better (at least for four hours) with the ebb stream along the coast, which here sets to the north-west, instead of meeting it nearly at right angles, as at present.

3rd. The Bar, or rather its nucleus, is formed by a part of the Scar composed of alum shale rock, and in low spring tides the water falls out 2 feet below its surface; so that, however the freshes may scour away the sand, this Scar remains as a weir across the harbour, ready to catch and retain every particle of sand thrown in by the waves. Besides the additional evil of risking a ship's breaking her back upon it in the event of striking, if running in in case of great need before a heavy sea. This should be immediately remedied. The alum shale is not a hard rock, and blasting under water has lately become so common a process, that there is no excuse for its being allowed to remain—especially as I understand five vessels have been wrecked on it during the last few years.

The short time I had at command would not allow me to walk along the upper part of the banks of the river; but in reply to my inquiries, I learnt that there are several obstructions to the free flow of the tide, which are incompatible with a good state of the harbour. Such as a ford across the river; a new narrow straight channel in part substituted for the former wider and circuitous one, (said, I think, to have been made by a railway company); and an addition to a quay lately erected projecting into the river some distance below high-water mark; but the great evil is, a dam or weir of a mill (the name of which I forget) across the river, which completely stops the flow of the tide upwards in its natural channel.

Besides these grievances, it was pointed out to me that the back of the west pier is the usual place of deposit for the rubbish of the town, which at the next high tide is washed down and carried into the harbour on the flood; while, throwing ballast over in the harbour is considered so venial an offence, that three men brought before the magistrate for doing so only the Saturday preceding my visit, were not fined, but only reprimanded.

Need we wonder at the encumbered state of the harbour and the dry bar.

Yet Whitby is a port of much consequence. Here are 14 building slips and 7 repairing docks, employing 300 shipwrights; 50,000 tons of shipping belong to the port; 2000 arrivals and sailings take place annually; its seafaring population consists of 2500; its coast fisheries employ 244 boats, and 750 men; quarries of alum rock, whinstone, and freestone, are in the immediate neighbourhood, and the Egton, Aislaby, and Cragwell stone is in request all along the coast for building.

The revenue of the port, too, is 3600*l.* a-year, partly derived either from a passing toll on shipping, or a tax on coal, specially imposed "for the improvement of the harbour."

Here are 65 Commissioners of the port, noblemen and gentlemen of the first station in the county, including among them the representative of the town, himself a sailor and shipowner, and one of the most intelligent and experienced members of the Trinity Corporation. I can only imagine, therefore, that the real state of the case is not laid before them. Knowing, as I do full well, the vital importance of a good harbour on this part of the coast, too notorious for its shipwrecks, I would venture to entreat them to see and examine themselves into the real state of the harbour, to take the opinion of one of our most eminent engineers, and to spare no expense till every obstacle is removed that impedes the free flow of the tide, and by dredging and other means to encourage it to flow up the river Esk as far as they can, so as to command all the natural backwater possible. Something was said, if I remember right, by the engineer, about damming up water to sluice out over the bar, but having seen in nearly every case in which it has been tried the utter inefficiency of such artificial backwater, I would trust to the free use of the dredge to form a reservoir in the natural bed of the river, which plan has the advantage of securing the unceasing scour of the tide twice a day, or 704 times a year; and this scour joined to the winter freshes, and the removal of the Scar, would, I doubt not, effectually exonerate Whitby from the reproach of being a 'bar-harbour.'

During the two months we have employed on this coast, on the surveys of Scarborough and Filey Bays, which have been completed by Mr. E. K. Calver, master and assistant-surveyor of this ship, we have repeatedly run down here, and each time I have been more impressed with the great want of a large buoy or beacon at the extreme end of Whitby Scar,* which is a very dangerous ledge of rocks, covered, except at very low tides, extending more than half a mile off shore with deep water close to; the same want, although perhaps not to so great a degree, is experienced at the end of Filey Brig and Flamborough Head Ledge. I have lying by me a list of 14 vessels wrecked on the Brig, many of which doubtless might have been warned off by a buoy or beacon at its end. On Flamborough Ledge, you may yourself remember we saw two light colliers at once; and it was here that the Driver, war-steamer, ran ashore and was much damaged.

Scarborough Harbour might be much improved by the west pier being carried more to the westward, and placed so as to shoot the sand and eddy tide off, past the eastern pier-head, instead of leading it into the harbour as at present. The harbour trustees are crippled in their exertions from the

* Placed in June, 1845.—[ED.]

want of funds, the corporation claiming a part of the dues, they have, however, recently evinced much public spirit in clearing out their eastern harbour, and in erecting a self registering tide gauge at the pier end. Its record is to be accompanied by a barometric register, and a journal of the winds and weather, to be kept in the lighthouse by the intelligent harbour-master; this is the first instance on this part of the coast, of proper attention to the phenomena of the tides, on which most of our harbours are dependent for their very existence, and we trust that the good example may be shortly followed at other ports in the neighbourhood, and especially at Whitby and Bridlington Quay.

Filey Bay offers fair shelter for a few vessels in north easterly gales, if they can anchor well up under the lee of the Brig which is a remarkable natural breakwater running off half a mile in a south-eastern direction from the shore. The rocks are of calcareous grit, stratified and abounding in fossils; the strata dip about 12° to the south; a more inviting foundation for a breakwater can hardly be imagined, but unless it were continued round so as to form shelter from east and south-east, it would be of little use. Stone is abundant, and to be had for the carriage, and when Government shall be at liberty to attend to the wants of sailors on this part of the coast, which sooner or later must be done, Filey Bay will deserve attentive consideration.

The Spital, as it is called, a small ledge which projects from the Brig in a south direction, appears to have been the foundation of an artificial pier; it is formed of rubble stones of about 2 cwt. each, and may have been intended for the shelter of fishing boats, but never finished, there is no record or tradition of its construction.

Bridlington Bay is the only good shelter in north-easterly gales on this coast, and in a continuance of such winds, 200 vessels may be seen lying here under the shelter of the Smithick Sand, which helps materially to break the sea, and would form an admirable foundation for a breakwater, and so make this bay a harbour of refuge. It was from strong evidence of the value of this bay, and of the utility that would result from an enlarged inner harbour, with convenient access for getting off provisions and water for wind-bound ships, that Parliament granted in 1837, a passing toll to be levied for the enlargement and improvement of the harbour by building a new south pier; under this Act a sum of upwards of 18,000*l.* has been raised, which appears to have been expended in a north pier, which is a fine piece of masonry, but is little or no shelter to the harbour from southerly gales—in September 1843, I found the plan for the south pier had only just been decided on; during the last month I have seen the works in progress, and it is said that they are to be completed in Sept., 1846; the pier is to be 330 yards long by 17 yards wide, the facing to be of Whitby stone, to be filled in with square masses of hard chalk; and the entrance of the harbour to be deepened to 18½ feet below the high water of ordinary spring tides.

I trust that special care will be taken to see that the contract is strictly fulfilled; yet blocks of chalk are doubtful materials to be employed as a core to a pier exposed to the heavy sea, which at times breaks in here in a southerly gale, and we know that at Ramsgate Pier, under the lighthouse it washed out, and was obliged to be replaced by stone. Care will be requisite too, to see that the foundations are laid deep enough, as the sand is very light, and it may so happen that the very erection may cause a scour along its outer end that would undermine it in a short time.

The landing place at the north pier is so far up the harbour, that boats cannot get near it at low water; and with any sea the harbour is unapproachable at that time, except by the Yorkshire cobbles, which are well adapted for taking the beach. I found no tide scale here, and no register of the tides kept; the harbour lights seemed to be but a poor affair; the harbour itself encumbered with sand, and I must add that there appeared many symptoms of the want of an efficient harbour-master.

As both Bridlington and Whitby levy public tolls on shipping, or on coals, it would seem but right that Government or Parliament should have some control over the manner in which such funds are expended.

We sail this afternoon for Shields to replenish our coals.

I am, &c.,
JOHN WASHINGTON, *Captain.*

To Capt. Beaufort, R.N., F.R.S.
Corr. Inst. France. Hydrographer.

No. 25.

Report of Mr. James Walker, C. E., on Whitby Harbour.

Great George-street, 4th January, 1845.

MY LORD AND GENTLEMEN,

Instructions.

THE substance of the resolution of your meeting of the 3rd April, communicated to me by the Marquis of Normanby, is,

That I survey the piers and harbour of Whitby, and report my opinion on the best way of extending and improving their capabilities and approaches.

Surveys.

Having in July last despatched my assistant, Mr. Drane, to measure and plan the entrance and the harbour, and to make observations on the river and tides, I visited Whitby in August, and made such survey as the time and state of the tides permitted. I also took the opinion of pilots and others, and afterwards attended a meeting at which Mr. Fishburn presided.

Circumstances obliging Mr. Drane to leave Whitby, I sent down Mr. Comrie, a surveyor of great experience, early in October, to complete the necessary surveys, plans, and sections; and during the ame month I again visited Whitby, continued my survey, and took additional evidence respecting the harbour and river. After my survey a meeting of the trustees was held, at which the Marquis of Normanby presided, when I was interrogated on various points, and gave my opinion generally, so far as I then had the means of forming one.

I consider that I was thus in possession of the means for judging of the defects of the harbour, and reporting the remedies that appear to me best suited for lessening or removing them; and I proceeded to give these subjects my best consideration.

Having completed the draft of my plan and report, I went to Whitby again in December, when I explained my ideas generally to Mr. Pickernell, your engineer, and Mr. Clark, your harbour-master, and having discussed the various practical matters with them, I believe I may say that there is little or rather no difference of opinion between us in any matter of importance.

APPENDIX.

No. 25.

Description.

Previous to reporting my opinion, it will be proper to give a general description of the present state of the harbour and its entrance; for although these must be familiar to most of you, my report may have to be submitted to others, who have little or no personal acquaintance with Whitby.

Whitby is situated in latitude 54° 30′ north, and longitude 30′ west, 26 statute miles south-east of the river Tees, and 17 miles north of Scarborough, the two nearest harbours. The River Esk, of which Whitby Harbour may be considered the "mouth," is a very small stream in times of drought, but forming the drain of a hilly country which extends 16 miles into the interior, it sends down considerable floods during the rainy season. The tide which flows up the channel of the Esk to the tail of Ruswarp Mill, a length of two miles and a-half, and fills the small bay or estuary opposite to the town; contributes in its return to assist the land floods in carrying out the sand, and in forming the entrance and the harbour. Of the two forces the land water is, as will be seen afterwards, by far the more important. The scour of the tidal water, taken separately, is of little or no account; its only value in this respect is as an auxiliary to the land floods.

To these operations of nature, the formation of the town and of the harbour of Whitby is no doubt owing; but they have been materially aided by the artificial works done at various times, particularly by the erection of the piers, which have guided and confined the land and tidal water out to low water at sea, and (to an extent) protected the shipping within them.

The bearing of the entrance of the harbour from the turning or swing bridge which divides the outer from the inner harbour (a length of half a mile) is north-north-east, one-third east by compass, or nearly *true* north. In this length there is a considerable curvature to the westward, and several projections, as shown upon the plan, which tend to break and reduce the range of seas in the harbour.

Tides.

At the harbour's mouth the rise of tide is as follows: upon zero* of the gauge affixed to the quay below the bridge (which is one foot above the level of low water of spring tide)—

	ft.	in.
Average of neap tides upon the gauge	11	0
Or from low water	12	0
Average of spring tides upon the gauge	16	0
Or from low water	17	0
Making therefore the depth of water upon the gauge at the average of spring and neap tides	13	6
Equinoctial spring tides ebb two feet under the average level of spring tides, and rise two feet higher, making a total flow or lift of	21	0

On the days of full and change of the moon it is high water at half-past three o'clock. The best tide is the second day after, say at five o'clock. The tide is, as in most other places, influenced by the winds; north-west causing the best flow, and south-east the worst.

Outside the harbour is a flat bed of alum rock, called "Whitby Rock," and the Scar, extending upwards of half a nautic mile from the pier head. The current of tide is what is commonly known as "tide and half tide," that is, it runs to the south for two hours and a-half after it is high water at the harbour's mouth, and to the north for two hours and a-half after low water at the harbour's mouth, the greatest velocity being two miles and a-half per hour. Inside, or near the harbour's mouth, the first of the flood tide is directly into the harbour, the Scar being so high as to prevent a current along the coast; but when these are covered it runs also to the eastward, towards Saltwick Nab, and continues in that direction until about an hour after high water, the greatest velocity being about half flood.

Rocks.

The "Scar" and "Whitby Rock" before referred to covers the whole area to the eastward of a line drawn *true* north, from the middle of the entrance; close to the piers the rock shows a little above low water, and the outer end of the east pier is founded on it. Immediately outside the entrance it falls in 100 yards to 6 feet under low water, and in the next half mile does not deepen to more than 10 feet under low water. A portion also of the rock near its outer end, which lies north-east of the harbour, at half a mile distance, is dry at low water of low spring tides. Between the rocks and the shore is a space, over which the depth is from one to two feet greater than over the average of the rock outside it, and the surface is more regular. In fine weather this forms a passage for small vessels, called the Sledway. On the west and north sides of the rock there is a sudden drop along its edge to nearly twice the depth upon it, which depth still increases to the westward, where the bottom is clay, forming the roadstead with nine fathom water, at less than a quarter of a mile from the west edge of the Scar.

It is evident that these rocks must render the harbour unapproachable for vessels of burthen from any point east of north-north-east, except at the high water of spring tides; but this disadvantage is, to a degree, counterbalanced by their breaking the heavy seas, with winds to the eastward of north-east, so that the harbour is partially protected except from winds between north-west by north and north-east, seven points only, to which it is quite open.

Piers and entrance.

As the direction of the west pier is north-east, as much advantage has been taken of the rocks to protect the entrance as could be taken, consistently with the facility of ships entering. The north-north-east gales just clear them, and at the same time have a fair run between the piers: hence the greatest range into the harbour may be expected, and I believe is with north-north-east gales. With all winds to the eastward of north-east, although there may then be greater surf, there will be less *swell* and *range*. Again, whenever the wind gets to the westward of north-west by north, the seas (as may be inferred from inspecting the plan) get into a direction more along the land or across the entrance, and therefore tend less to cause *swell* or *run* in the harbour; but north-west winds are attended with another and more permanent evil, viz., agitating the sand upon the shore to the westward, and bringing it round the west pier into the harbour's mouth, there forming the bar.

These are therefore the two principal defects of Whitby Harbour; viz., the great range of sea into it during gales between north-west by north and north-east, and the collection of sand producing a bar between the pier heads with westerly winds.

The present formation of the entrance, which I am about to describe, does not appear the best for counteracting these evils.

The width between the piers is 280 feet at the bottom, and 300 feet at the top of the walls. The effect of so great a width is to admit the seas into the harbour and to add to the swell.

The west pier, in respect to its length and breadth, and as an engineering work, is one of the finest in the kingdom; the last addition to its length was about 40 years since, by Mr. Pickernell, grandfather of your present engineer. Its direction is, as has been stated, north-east, finishing with a bold

* Zero upon the gauge is 22 feet under the ground-floor of the public Subscription Baths.

circular head or funnel-mouth, the effect of which shape is increased by the head of the east pier being *retired*, as has been described. This form tends farther to admit the swell, which, after getting round the head, runs up the smooth inside surface of the north pier with great power, breaks over the Scotch Head with violence, and ranges round the end of it, up the harbour, and even through the bridge (although the four openings under it are altogether only 117 feet), to such an extent as to cause considerable swell in the inner harbour.

The direction of the east pier is north north-west, forming an angle 67° 30′ with the west pier, which projects about 100 yards beyond the east pier. From this inequality in the length of the two piers arises another evil, viz., a difficulty to ships entering the harbour, through the eddy, between the termination of the west and that of the east pier, this space being out of the way of the fair *run* of flood tide. A ship caught in this eddy with a scant wind is apt to lose both her "way" and her "steerage" before she gets within the east pier, so that the action of the tide pressing her starboard quarter to the eastward, while the eddy is turning the larboard bow in the opposite direction, her *head* is brought round to the westward; she then drifts bodily to the eastward, and is in danger of either striking the east pier or of going upon the rocks behind it.

Bar.

During my two first visits to Whitby, the weather was fine, and the bar, owing to the long drought, was bad. Taking zero upon the tide-gauge, as being the low water, the sand was from three to four feet above this level for the western half of the width between the piers; the remainder was nearly dry at low water. The spit of sand extended out 100 yards in an easterly direction before it reached low water.

In October, the fresh-water course near the pier heads was more tortuous. From the "Scotch Head" it shot off to the eastward, until nearing the east pier, when it crossed back to the west pier, and then turned again to the eastward, leaving a shorter spit against the west pier. In the level of the sand, or facility for ships entering, there was but little difference. I name these particulars to show the present uncertainty of the channel and its small depth, when it has been long without a land-fresh to scour it. It is evident that there was, at the above time, only 12 feet at spring and 8 feet at neap tides, excepting in the narrow and shifting fresh-water channel. A good river-flood would, it was stated, increase the velocity of the outgoing current near the entrance, from half a mile (its then speed) to upwards of three miles per hour, and would clear the sand down to the rock, giving 3 to 4 feet additional depth, or from 15 to 16 feet at spring tides, and from 12 to 13 feet at neap tides, which was the case when I saw it in December. This was partly owing to a late fresh in the river, but still more to the seas during six weeks of east winds, driving the sand up towards and round the "Scotch Head," where it was heaped up to a considerable height.

A ship drawing about 15 feet 6 inches got into the harbour about four years since, but this is a rare case; and it will be seen by the above figures that all circumstances had then conspired to place the entrance in the best condition.

Advantages as a Harbour of Refuge.

Notwithstanding these disadvantages, Whitby has occasionally been most useful as a Harbour of Refuge, particularly during north-west gales. I was informed of one case in which 75 ships, and of another in which 60 ships had entered it for refuge in one tide. A considerable part of these would, it was supposed, have gone ashore had they not got into the harbour. Mr. Aaron Chapman, the present representative of Whitby in Parliament, is a native of the town, and formerly commanded ships upon this coast. Thus, and from having since frequently surveyed the coast as an Elder Brother of the Corporation of Trinity House, he is well acquainted with the port. He states, in his evidence before the Shipwreck Committee, the public importance of the harbour; in proof of which he names that he has seen from 50 to 100 vessels go out in one tide, and that he saw on one occasion 70 to 80 sail driven in by privateers.

These cases do not alter the facts as to the depth, but they prove the truth of the saying that "Any port in a storm;" and they show the importance, upon public grounds, of improving and preserving a harbour which is, from its position, a port of refuge for life and property, though by no means a perfect one.

Defects.

I now proceed to state some of the interior matters to which my attention was directed, as affecting the harbour and its entrance.

Ruswarp Weir.

The dam or weir that crosses the river at Ruswarp Mill is a complete *stop* to the flow of the tide, as it is only in very extreme cases that it reaches the top of the weir. As a good spring tide rises four feet below the weir, the tide must have flowed some distance higher up the Esk, before the mill was built, than it does now; and, if the weir were removed, the channel above it would gradually deepen, and the tide flow up as before. On the other hand, the river above the mill is narrow, with rising ground on each side; and when the land-freshes are coming down the tide is prevented from going up. Such an erection as this weir, although proposed by the owner of the soil and the lord of the manor (which Colonel Cholmley, the proprietor of the mill, is), would be objected to now, every encroachment within high-water mark, that is injurious to the harbour, being unlawful unless made by Act of Parliament; but, as the mill and the weir have stood as they are for 92 years, and are valuable, the removal, without Colonel Cholmley's consent, is I presume out of the question.

Encroachments.

Other encroachments upon the tideway are more recent. Some of them can, I trust, be removed; or, if this cannot be, their increase may be prevented.

By the Whitby and Pickering Railway Act, a new straight channel was substituted for the old circular course of the river, about a mile above the town, to enable a straight line of railway to be made. This was proper, for the railway is a valuable addition to the town; but the new course being narrower at high water, as well as shorter than the old, the tidal receptacle has been excluded from the old channel by means of a dam. This exclusion does not appear to me at all necessary for the railway, while its tendency is injurious to the harbour; and, unless there is some stronger objection to the removal of the dam than I have discovered, I think it ought to be removed now, and the water again admitted to ebb and flow with the tide, by which 20,000 to 30,000 additional cubic yards of water would pass in and out of the harbour at each spring tide.

About half a mile below Ruswarp there is a ford across the river, made, as I was informed, under the Railway Act; as it is broken through by the current, so as to be useless, I hope there is no objection to its entire removal.

A little higher up the river is a natural obstruction, by which the water is kept up. As this, and whatever tends to prevent the free flow and ebb of the tide, is injurious to the harbour, a jealous care for its preservation would be shown by attention to what may, taken separately, appear almost trifling.

Ballast.

Another and greater evil is, that the sides of the river and of the harbour within high-water mark are used as the place of deposit for the ballast of ships and the rubbish of the town. Only the week

APPENDIX. No. 25.

before my October survey some offenders in this respect had been charged before the magistrates with throwing chalk, rubbish, and gravel upon the east shore of the river, opposite the "Batts," a mile above the town. The quantity upon the bank appeared to be considerable when I saw it, although a portion of it had been washed down into the stream, and was still visible. The case was proved, but the party let off on paying the costs of the information. Some years since, to throw the ballast within the high-water line was said to be the usual mode of disposing of it. At the present time a wharf is being formed for the Railway Company, between the present quay and Barker's quay, where there was formerly a considerable depth of water; I did not ascertain that permission had been granted for this. Now, although the formation of wharfs is useful for trade, yet I think that such an encroachment ought not to be made without a regular application, and that the permission, if granted, ought to be coupled with an obligation on the party to fill up behind his wharf with material taken from the river *between high and low water mark*, by which a double good would be effected, through the formation of wharfage and the deepening of the harbour, instead of using the ballast of ships for the purpose of backing. As the railway wharf required a channel up to it, this has been made, not at, I believe, the expense of the Company, but of the Commissioners, the material that was excavated being carried out to sea, in place of being applied to back the wharf.

It must be apparent that these gradual encroachments, although small in each month or year, must, in the course of time, not only reduce the depth of the harbour, but also to lessen the contents of the basin. And it is to be particularly observed that the scouring effect upon the channel, which depends mainly upon the *velocity* of the current, is lessened in a more rapid proportion than the quantity is. As there were no correct measurements by which to compare the present with former depths, I directed Mr. Drane and Mr. Comrie to take a number of cross sections of the river, from the entrance of the harbour up to the mill, to assist me in computing the area and quantity of backwater. A copy of these sections accompanies this Report. They are numbered from 1 to 36, and their place marked by dotted lines and corresponding numbers on the Plan A. These, with the correct plan I recommended, and which Mr. Pickernell has undertaken to make from a new survey, cannot fail to be very useful, if applied, to enable you to preserve and improve the harbour; and as the trade and value of property in Whitby depends so much upon the state of the harbour, no one having an interest in the town can be indifferent to the question. After the plan is finished, the limits of the harbour should be periodically surveyed, compared with the plan and sections, and the differences regularly reported on by your engineer.

As a means of preventing the evil I have just referred to, some ready and well-defined way should be taken of disposing of the ballast, which there is not at present. It might be landed and drawn up by engine power, as in the Tyne, or carted and shot over the east cliff, or put into boats with false bottoms, carried out to sea, and dropped to the eastward of the harbour.

The question is, which is the cheapest? The result of a calculation made by me, from premises furnished by Mr. Pickernell, was, that the disposal of ballast in the present injurious way costs more than if it were boated out to sea; if so, the compulsion to take it out would be no hardship upon any one. I strongly recommend that Mr. Pickernell be requested to well consider the subject, and report his opinion; this done, and the means recommended, any attempt to commit a nuisance in the harbour should be so noticed as to make it an example and warning to others. It is quite evident that if the harbour, even in its present state, is to be preserved, the ballast thrown into it must be taken out again, and thus there are two expenses, one of which would be rendered unnecessary if the proper course were adopted at first.

Rubbish.

Another regular and almost authorized (at least not objected to) mode of disposing of the town rubbish is into the sea, on the west side of the battery, behind the west pier, whence it is washed down by the seas in north-west winds, and brought to and round the end of the pier into the harbour with the flood tide. The marks of this were visible upon the shore when I was at Whitby: it ought to be prevented; and when Mr. Pickernell shall have determined the place for it on the east side of the harbour, the west side may be effectually closed; but to attempt this without offering a substitute would be almost in vain.

Proposed improvements.

I come now to state what appear to me the most certain means of improving the harbour, and to be essential for that important object.

They consist chiefly of—

1st. An improvement in the piers, to facilitate the entrance of ships into the harbour, and to lessen the swell or run within it.

2nd. Forming the inner harbour into an occasional back-water, for the removal of the bar.

Piers.

First, as to the piers:—

Having stated that I consider the unequal length of the piers to be the principal cause of the danger and difficulty of entering the harbour, and the great width, with the formation of the end of the west pier, to be the causes of the heavy seas that enter it, the remedies that naturally present themselves are to extend the east pier as far out as the west pier, in reference to the line of coast and set of tide, and to give this additional length such a direction as at the same time to narrow the entrance; also to give the end of the west pier a shape which shall be less inviting for the seas to enter the harbour than the present funnel shape.

I beg now to refer you to plan B, which shows (from Mr. Comrie's survey), on a larger scale, the part of the river from the entrance of the harbour up to and including the bridge.

It will be seen that I have proposed an addition to the east pier, in a direction north-north-east quarter north, for a length of 220 feet, when there is a return of 15 feet to the westward, and the line is then bent a few degrees to the east of north-north-east for a length of 20 yards, this forming one side of the *throat of the entrance*; it is then rounded off with a radius of 30 feet to a sea face or front, square with its side, and by an addition to the present circular end of the west pier, the west, or opposite site of this "throat," is formed so as to correspond with, and be parallel to, the east side, giving a width of entrance of 150 feet at bottom, and 170 feet at top, (the average width being 160 feet,) and the west pier being rounded off to the same radius as the east. This general confirmation will be better understood from the plan.

I have been particular in stating the bearings and dimensions, that a correct opinion of my proposal may be formed by your harbour-master, and other practical men. My opinion is, that while the entrance will be sufficiently wide, the harbour will be rendered comparatively quiet, and the facility of entrance much increased; that there will be less disposition to eddy, and as its consequence, less deposition of sand; and that what sand does collect will have a better chance of being carried out clear of

the heads by the outward current. Also that the extension of the east pier will prevent the sand from being driven into the harbour during easterly gales.

I am not aware that more can be done for the entrance without extending both heads out to sea, the cost of which would be very great.

If, however, the entrance were as perfect as art and science (without limit to expense) could make it, the dependence upon land floods for clearing away the accumulation of sand will always make it, not only a bar harbour, but an uncertain bar harbour, good after rains, bad after continued dry weather. For a harbour of importance for trade, and occasionally for refuge, this certainly is a bad character. Back-water.

Having given this subject my attentive consideration, I think the most effectual remedy is, to place in the contracted part of the harbour, close below the bridge, a pair of wide gates in line with the bridge, opening for the passage of ships, and sluice gates on each side, so that by shutting all the gates at high water, when the bar is bad, and thus penning up the water in the inner harbour until nearly the time of low water, the sluices may then be opened, and the contents discharged through the outer harbour and upon the bar. As in ordinary spring tides a head of 14 feet over an area of 40 acres would be penned up to form a back-water, the power to clear the outer harbour and entrance would be so great as, I think, effectually to remove all sand from between the piers down to the rock, and even *below* the present level of the rock, should it be thought desirable to excavate it. The position of the gates and sluices here referred to, is shown upon plan B, to which I request your attention. If the quantity were small, and the effect to be produced by the *velocity alone* of the water issuing from the sluices, the distance of the bridge to the bar being half a mile would be an objection; but I consider the effect in this case to be more nearly represented by the current of a river which is dependent for its effects upon its quantity, and upon the slope of its surface. If the quantity passing down the channel from the sluices be as *great* as that of the river Esk in a flood, the effect of the back-water in the same time will be similar, and the whole width from the sluices downwards as effectually scoured by it.* If a back-water is to be formed at all, this is, I think, the best mode of making it; and I do not anticipate any difference of opinion on this point by Mr. Pickernell, as he has now given it his matured consideration. It would be quite impossible to collect even a tenth of this quantity in the triangular space between the head of the east pier, and the Herring-house, (Colliers' Hope,) while the walls for enclosing the space would render the penning of this smaller quantity more expensive than forming a pen at the bridge, where scarcely any walling would be required. Again, the enclosing so considerable a portion of Colliers' Hope might be objected to as confining the area over which the seas are spread, and partly expended after entering between the piers.

As the width of the *gates* and extent of *water-way*, by the plan, would be greater than under the bridge, the only inconvenience likely to be felt by the plan proposed by me, would be during the erection of the necessary apron and works.

I estimate the stonework of the piers, as described and recommended, at 30,000*l.* Estimate.

The cost of the sluices and gates may be 15,000*l.*; but it is proper to state, that this last sum is assumed from the magnitude of the work, and my general experience. To estimate the cost correctly would require detailed drawings, which I have not prepared.

If, however, the whole of the works, including contingencies, be taken at 50,000*l.*, this sum ought not, I think, to be considered great, in comparison with the public and private advantages that would result. And when the ports near you are being improved and enlarged, Whitby cannot be expected to maintain its trade and comparative importance, if it be allowed to remain subject to its present disadvantages.

I was prepared with a recommendation for lessening the present inconvenient swell higher up the harbour by a work at the Scotch Head, but as I think it probable that the alteration of the piers will sufficiently effect this object, I strongly recommend that your attention and resources be, in the first place, confined to the measures I have described.

I have the honour to be,
My Lord and Gentlemen,
Your obedient Servant,
JAMES WALKER.

P. S.—My surveyors and myself have to acknowledge having had every assistance and information from Mr. Pickernell and Mr. Clarke, which it would be remiss not to notice with thanks.

No. 26.

STATE of the RIVER THAMES in the Years under mentioned, from Evidence before the House of Commons in the Years 1732 and 1805.

At Low Tides.	1680	1732	1805
	Feet.	Feet.	Feet.
Abreast the Custom House	3 to 4	11 to 12	12
Hermitage, St. Katherine's	Almost dry	11 to 12	12 to 14
Wapping to New Crane	,,	13	12 to 14
New Crane to Bell Wharf	4 to 5	15	16
King Edward's Stairs	Almost dry	13	15
Queen's Stairs	3	13	15
Oliphant Stairs	5 to 6	13	16
Church Hole to Hanover Stairs	Almost dry	7	15 to 17
King's Mills	,,	12	17 to 19

540,000 tons of ballast were raised from Barking Shelf from August, 1819, to April, 1822, previous to which it was almost dry, but the river is now navigable. It appears that no ballast had been raised from the bed of the river Thames, nor any ships been moored from London Bridge to Limehouse, that the depths of water would have been less by 12 feet than they now are.

* The sluices, as shown upon the drawing, are calculated to discharge while the head continues a greater quantity than the land-flood of the river.

No. 27.

Messrs. Stevenson's Report on the Improvement of the River Lune.

In the month of March, 1838, we received instructions from the Commissioners of St. George's Quay to make a survey of the river Lune from Glasson Dock to Lancaster, and to report on the best means of improving its navigation.

Agreeably to these instructions we have surveyed the river, and obtained sufficient data to enable them to submit the following report and plan to the consideration of the Commissioners as that which they think best adapted for effecting the improvement of the navigation, which is justly considered an object of the highest importance, as it tends directly to advance the prosperity of Lancaster, and in time to exert a beneficial influence on the interests of a large portion of the inhabitants of one of the most populous counties in England.

Before entering on the subject of the proposed improvement we beg leave to lay before the Commissioners the data which we have obtained, and on which the suggestions in the following Report are framed; and for this purpose we refer them to the accompanying plan and section.

The plan extends from Lancaster to Glasson, and shows the high-water line and banks, or margin of the rivers, together with the low-water channel and sand banks. The soundings marked in black colour are the depths in the channel at low-water when the river is in its state of summer water, and those marked in red colour are the depths at high-water of an ordinary spring tide rising 21 feet at Glasson and 10 feet at Lancaster. The large figures on the margin of the low-water channel indicate the perpendicular rise of tides at the places where they occur. A longitudinal section of the bed of the rivers from Lancaster to Glasson was also made. It was thought unnecessary, however, to show more of this section than that part which extends from Lancaster to Coleway, as the operations which we recommend to be undertaken, in the first instance, are confined to this stretch of the river. During the progress of the survey a register of the rise and fall of the tide was kept at Lancaster Quay, Heaton Point, and Glasson Dock, by means of graduated tide gauges, fixed in reference to a level line accuraetly traced from Lancaster to Glasson, and all the high-water soundings on the plan, and the heights on the section have reference to the high-water of the same tide.

To enable us to make an estimate of the probable expense of the projected improvements, we found it necessary to make a line of borings in the channel of the rivers from Lancaster to Heaton, in order to ascertain the formation of the shoals and fords to be removed. Sections were also made of the principal bays and marshes in the line shown on the plan, with the view of determining the places where the materials obtained by dredging could be deposited with most advantage or applied to reclaiming the marsh lands along the margin of the river wherever an extension of the land might be made without risk of injury to the navigation.

The fords and shoals in the upper part of the Lune form the principal obstructions to its navigation; but they are neither numerous nor extensive, and are confined to the reach of the rivers between the quays of Lancaster and Coleway Point, a distance of about two miles and three-quarters. By referring to the plan and section, on which, as already stated, all the soundings and vertical heights have reference to the level of high-water of an ordinary spring tide, it will be seen that in some parts of the navigable track there is a depth only of 12 feet at high-water. The traffic of loaded vessels of ordinary tonnage. drawing from 10 to 11 feet, is thus extremely circumscribed, as vessels of that draught can only reach the quays of Lancaster during spring tides, and even then with considerable difficulty; and when they have the misfortune to lose the high tides they are under the necessity of waiting in the river for the next springs, a delay which is attended with great expense to the owners, while the vessels and cargoes run considerable risk of damage from lying so long in such situations. It therefore becomes an object of the utmost consequence to extend the opportunities of reaching Lancaster in one tide by affording a greater depth of water, and by hastening the arrival of the tide in the upper parts of the river, and to this we have particularly directed our attention.

The first obstruction which is met with on leaving Lancaster is Scale Ford at the upper end of Salt-area, a high ridge stretching across the river from bank to bank, and extending about 700 yards along its bed. The highest part of this ford, when the river is in a very low state, is almost laid dry, and has only a depth of 12 feet at high-water. Several borings were made on the Scale Ford to the depth of from 10 to 13 feet below the bed of the rivers, and it was found to consist of a crust of hard and compact gravel about three feet in thickness, under which lies a bed of soft clay. Through this clay the jumpers were easily driven by a light hammer about a quarter of an inch at every blow.

The next obstruction is Baffler's Ford, situate at the lower end of Salt-area, and extending 560 yards along the bed of the river: when the river is in a low state it is almost dry, and at high-water of ordinary spring tides it has a depth of 12 feet 10 inches at the shallowest place. The borings made on this ford proved it to be a crust of hard gravel of from two to three feet in thickness, resting on a mixture of soft gravel and sand.

At Oxcliff, Snatchems, and Heaton considerable shoals occur, extending to 313, 516, and 653 yards respectively, along the bed of the rivers. These obstructions, however, are merely banks of sand and loose gravel, and from the facility with which the borings in that part of the river were made, there is no doubt that they will be removed with comparative ease.

The depth of water on these shoals varies from 13 feet 9 inches to 15 feet 3 inches at high-water of ordinary spring tides. Opposite the lower end of the quays at Lancaster there is an accumulation of gravel in the middle of the stream, which is by no means extensive, and will be easily removed.

To the removal of these obstructions we would, in the first place, direct the attention of the Commissioners, as the works of most importance, which must naturally precede all the others. The Commissioners for the improvement of the Lune navigation have erected an extensive weir at Scale Ford. The object of this erection, it is believed, was to cause the water which formerly passed on the north side of the Salt-area to pass down the south channel, and, by erecting an additional scour at that place, to remove the Scale Ford by the increased action of the current. The gravel of which the fords are composed, however, is of too hard and compact a nature to be acted on by such means, and the consequence is, that the weir has not produced the contemplated improvement to any useful extent.

The great object to be kept in view in carrying into effect the improvement of the navigation of the Lune, is the free admission of the greatest possible quantity of water from the sea, as reliance must

be chiefly placed upon the scour produced by the tide, and not upon the current of the fresh water as the chief agent in keeping open the navigable channel of this river.

In the course of our investigations on the subject of the tides at the Lune, we ascertained the following facts, by a due regard to which we have been in a great measure guided in forming our opinion as to the best means of improving the navigation, viz. :—

1st. The high-water mark of each tide is on the same level at Glasson, Heaton, and Lancaster, and the time of high-water of each tide is nearly the same at these places.

2nd. The level of low-water at Heaton is 3 feet 9 inches below that at Lancaster, and the level of low-water at Glasson is 7 feet 3 inches below that at Heaton, making the level of low-water at Glasson 11 feet below that at Lancaster.

3rd. On the 6th of September, 1838, when the tide rose 21 feet 1 inch on the Old Dock Sill, by the Liverpool tide tables, it rose 23 feet 6 inches at Glasson, 16 feet 3 inches at Heaton, and 12 feet 6 inches at Lancaster.

4th. The distance from Glasson to Heaton by the low-water channel, $3\frac{1}{4}$ miles, and the distance from Heaton to Lancaster is 2 miles and $\frac{1}{8}$th; making the whole distance from Glasson Dock-gate to the lower end of St. George's Quay at Lancaster, by the navigable channel, $5\frac{1}{2}$ miles nearly.

5th. In spring tides the tide takes 1 hour and 10 minutes to flow from Glasson to Heaton, and 40 minutes from Heaton to Lancaster, or 1 hour and 50 minutes from Glasson to Lancaster.

6th. In neap tides the tide takes 3 hours 50 minutes to flow from Glasson to Heaton, and 1 hour and 10 minutes from Heaton to Lancaster, making 5 hours from Glasson to Lancaster.

7th. At Glasson, spring tides rise for 3 hours 20 minutes, and fall for 7 hours 40 minutes; and neap tides rise for 6 hours, and fall for 6 hours; and at Lancaster spring tides rise for 1 hour 40 43 minutes, and fall for 4 hours 10 minutes, and neap tides rise for 1 hour, and fall for 2 hours 40 minutes.

Proposed Improvements.

From a consideration of these data, and the depths shown on the section, it is obvious as already stated, that the natural mode of improving the navigation of the Lune is to remove the fords, and other sudden changes in the form of the river's bed, so as to reduce the injurious effects of these obstacles in hindering the free ingress of the tide, as well as to afford a greater depth of water for vessels of a certain draught in the upper parts of the river. The advantages of such a change in the circumstances of the channel are twofold, for not only will vessels of greater draught be enabled to pass those shallows at high-water, but the more free and unimpeded flow of the tide, which must be the result of deepening the upper parts of the river, and removing the ridges which oppose an earlier entrance to the waters of flood, will give vessels a better chance of reaching the upper parts of the navigation at the proper time, by enabling them to start at an earlier period of each tide.

The operations which we propose may be divided into two compartments. The Commissioners should, in the first instance, confine their attention to the deepening of the present navigable channel in the upper part of the river. By this means, as already stated, the tide will be brought earlier to the quays of Lancaster, and this reach of the river will be rendered suitable for vessels of a greater draught of water than those at present employed in the trade of the port. For this purpose the several fords and shoals which have already been enumerated must be excavated to the extent shown in red colour on the longitudinal section, which would afford a depth of 16 feet all the way to Lancaster Quays in ordinary spring tides.

We are happy in being able to state that this operation will be attended with very little difficulty, and may be effected at a very small expense, while the benefit which the port of Lancaster must undoubtedly derive from it will be very considerable. The borings and examination of the subsoil of these fords have proved that the materials of which they are composed, although generally of a compact and hard nature, are nevertheless such as may be easily removed by a steam dredging machine of moderate power, and of the ordinary construction, applied and worked with care.

It is conceived to be an object of great importance to obtain a sufficient depth of water up to the quays of Lancaster at as early a period as possible. We have, accordingly, restricted their estimate of the improvements, in the first instance, to the formation of a channel 100 feet in breadth, having a depth of 16 feet at high water of ordinary spring tides, which rise 21 feet at Glasson and 10 feet at Lancaster. This important improvement in the navigation might be accomplished with one dredging machine in the course of one working season, at the expense of 7425*l.*, including the cost of a dredging machine and punts, all of which would afterwards be applicable to the further improvements of the river.

The second stage in the operations of the Commissioners would embrace the widening of the channel and the straightening of its course by cutting off the projecting points within the red dotted lines delineated on the plan. In this way a still greater volume of tide water would be admitted to flow freely up the river, and the passage of the tide from Glasson to Lancaster would be proportionably accellerated, while the navigation would be rendered more easy for the increased number of vessels, which, after the deepening of the channel to 16 feet, would come directly to the quays of Lancaster.

The widening of the river could be carried on with the dredging machine at an annual expense of about 1750*l.*, and could be completed, to the extent shown in the plan, in the course of three or four years, if the operations were formed on an extensive scale. In regulating the extent of their ultimate operations, the Commissioners would, of course, be guided by the prospect of a further increase of the trade and revenue of the port, which the effects of the first season's operations might afford, as likely to be the result of more extensive improvements.

The whole scheme proposed to the Commissioners might thus be completed in the course of four years. If the increase of trade should then warrant a further extension, the Commissioners might proceed to deepen the river from 16 to 18 or 20 feet, when it would be also necessary, in order more easily to preserve the increased depth, to widen the river at the site of the old bridge by removing its ruins which encumber the stream, and perhaps even to extend the dredging operations as far as the new bridge.

We are aware that some doubts may exist as to the possibility of preserving the proposed depth of 16 feet when once obtained; but after a careful examination of the river itself, both by boring and otherwise, we have no hesitation, from our experience on other rivers, in saying that the occasional use of the dredging machine, assisted by the natural scour of the tide passing four times over the river in 24 hours, will preserve the depth and breadth of channel, which we have recommended to the consideration of the Commissioners.

Appendix. No. 27.

The only subject connected with the proposed improvements that remains to be considered is the disposal of the gravel and other matter excavated from the river in forming the channel.

Several low lying tracts of land on the margin of the river might, with advantage to the proprietors and convenience to the Commissioners, be enclosed, an operation which has already been carried to a great extent at Adcliff; but we beg leave particularly to point out the necessity of using much caution in encroaching on the tide-covered banks of the river, and thus shutting out large portions of the tide water, and impeding the effect of that powerful, constant, and therefore most efficient of all agents in preserving the depth of navigable channels.

That we might be fully able to advise the Commissioners as to the means of disposing of the excavated stuff to most advantage, so as to keep in view the improvement of the navigation as the object of most importance and the acquisition of land as a secondary consideration, they made sections of all the large bays and marshes on the margin of the rivers. These were Ovangle, Heaton, and Coleway marshes on the north side, and Adcliff Bight, Thornbank Bight, and Conder Bay, on the south side of the river. The result of these sections is, that Ovangle and Coleway marshes are those which could with most advantage be enclosed. We have formed this opinion from the consideration that these portions of land lying on a higher level could be enclosed at much less expense and with much greater ultimate advantage than any of the others, while the quantity of water excluded by the operation will, of course, be less in proportion to the height of the present surface of the marshes.

The quantity of stuff which would require to be excavated during the first season's operations in deepening the channel to 16 feet at high water is about 60,000 cubic yards. On Ovangle Marsh an embankment, containing about 23,000 cubic yards, placed in the position shown by dark green lines on the plan, would inclose about 55 imperial acres, and this could be easily overtaken during the first season's operations.

The quantity of land which would be gained by enclosing Coleway Marsh is about 80 imperial acres; but the quantity of stuff required to form the embankment for this purpose is about 128,400 cubic yards.

A portion of land extending to about 30 acres could, however, be enclosed at the east corner of Coleway Marsh during the first year's operations by an embankment in the position shown by dark green lines on the plan, containing about 54,000 cubic yards.

We have not the means of knowing which would be the most advantageous position, in a pecuniary point of view, for the Commissioners, as that must depend on the views of the proprietors and the arrangements that can be formed with them. We have no hesitation, however, in saying that, in an engineering point of view, the choice lies between Coleway and Ovangle Marshes, and that in adopting either, or indeed both of these positions, (should the future operations of the Commissioners require it,) the navigable capabilities of the river would not be injured, as both of the marshes in question lie on a high level, and are pretty far removed from the natural flow of the river.

Before concluding, we beg leave to draw the attention of the Commissioners, as conservators of the Lune navigation, to the necessity of exercising the right which they possess of enforcing the removal of the numerous stake and bag nets which at present project into the navigable fareway. These obstructions not only distort the natural flow of the river, but in fact present impediments of the most dangerous description to the vessels navigating it.

We, therefore, humbly suggest the propriety of the Commissioners enforcing their right of removing them, before the occurrence of some serious accident shall render this step imperiously necessary.

Probable estimate of the expense of improving the navigation of the River Lune, so as to obtain a depth of 16 feet at high water of ordinary sprihg tides up to the quays of Lancaster, by Robert Stevenson and Sons, civil engineers:—

	£.	s.	d.
Expense of a dredging machine worked by an engine of 12 horses' power, with punts and apparatus	5,000	0	0
Ten months' work of a dredging machine, at 175*l.* per month	1,750	0	0
	£6,750	0	0
Incidents on the above sum of 6750*l.*, at 10 per cent.	675	0	0
	£7,425	0	0

To complete the further improvements of widening and straightening the channel shown in the plan—

	£.	£.	s.	d.
Three seasons' work of a dredging machine, taken at 1750*l.* per annum	5,250			
Incidents at 10 per cent.	525			
		5,775	0	0
		£13,200	0	0

Robert Stevenson and Sons.

Edinburgh, December 14, 1838.

No. 28.

No. 28.

Statement relative to the River Dee in Cheshire. By David Stevenson, *Civil Engineer.*

Edinburgh, June 24, 1845.

I surveyed the River Dee from Chester to Flint in the year 1839, with reference to the improvement of its navigation, at the desire of the "Chester Dee Improvement Committee." I also in 1840, surveyed the upper part of that river from Chester to Pulford Brook for the Marquis of Westminster, with reference to the improvement of the drainage of the upper district.

The Dee rises in Merionethshire from the Lake of Bala, and, after a course of about 60 miles, reaches the city of Chester, which is 25 miles from the Bar. The following are the distances. Distances.

The Bar to Point of Ayre	4 miles.
Point of Ayre to Flint	10 miles.
Flint to Connah's Quay	3⅝ miles.
Connah's Quay to Chester	7½ miles.

The part of the river which extends from the Bar to Connah's Quay, 17⅜ miles, may be said to be an open estuary, and the part from Connah's Quay to Flint (7½ miles) is an artificial tidal canal, about 500 feet in breadth, the available breadth of which, however, is reduced to 250 feet by means of a series of groins or jetties projected from the southern bank. From the weir, immediately above the city for the use of the Chester mills, upwards, the river is dammed back, so as to present the appearance of a narrow lake, having a sluggish current through it.

The influence of the tides is greatly checked by these groins, and especially by the weir, but as high springs rise four feet above this weir, their influence is felt at Pulford Brook, seven miles up the river; how much farther I am not aware. Tides.

At the time the survey was made (1839) in many places the depth was 13 feet at high water, ordinary spring tides, and the available depth for shipping to Chester 12 feet. Depth of Water.

The high-water line was found, by an average of twenty-four observations, to rise two inches from Flint to Connah's Quay; and from Connah's Quay to Chester the rise was found to vary from four inches at neap to 14 inches at spring tides, giving, as the result of twenty-four observations, an average rise of six inches. The whole average rise on the high-water line from Flint to Chester is therefore eight inches.

The difference between the times of high water at the different stations was found to vary very much, and appeared to be more affected by the state of the winds, or some other cause unknown, than by the circumstance of the tides being neap or spring; but the average of the observations gave the time of high water at Flint twenty minutes earlier than at Connah's Quay, and that of high water at Connah's Quay thirty minutes earlier than at Chester, the whole average difference in time between high water at Flint and at Chester being fifty minutes.

The average level of the low-water line at Connah's Quay is 2 feet 6 inches below that at Chester, giving on the distance of 7½ miles an average fall of 4·09 inches per mile, and the level of the low water at Flint is 7 feet 6 inches below that at Connah's Quay, giving on a distance of 3⅝ miles an average fall of 24·59 inches per mile. The total fall from Chester to Flint is 10 feet, being an average fall on the distance of 11 miles of 10·9 inches per mile.

When the rise of tide as indicated by the Liverpool Tide Table is 18 feet on the Dock Sill at Liverpool, the rise in the Dee is 20 feet 10 inches at Flint, 13 feet 8 inches at Connah's Quay, and 11 feet 5 inches at Chester.

The bed of the river from Chester to the sea is soft, consisting entirely of sand without any admixture of gravel. Above the weir at Chester mill the bottom generally may also be said to be soft, but two fords of harder material occur, viz. "Watling Street," and "Broughton Fords," the former five and the latter one mile above the weir. Watling Street is composed of stones, supposed to be in the line of the Roman Road from Chester to London, &c. Broughton Ford is composed of sand and gravel. Formation of Bed.

The case of the Dee is peculiar as regards its navigation, having been improperly treated, first, by the erection of the weir for working the Chester mills; and secondly, by extensive embankments formed for reclaiming land.

The height of the weir above bed of river is 11 feet 6 inches; and the level of its top, if extended up the river, does not cut the bed at any point within the range of my observations, which extended seven miles to Pulford Brook. The level of the surface of the water at Pulford Brook is 2 feet above the weir, which is equal to a fall of 2 feet in 7 miles, or at the rate of 3·42 inches per mile. The obstruction caused to the tides by this weir is most prejudicial, as none but the highest tides extend above it, whereas, were it removed and the Watling Street and Broughton Fords taken away, a vast increase would be given to the daily amount of the tidal scour. The consequence of removing this weir appeared so formidable, however, as affecting the mill property, that the Navigation Committee of Chester, by whom I was employed to report on this point, could not attempt such an operation. This weir also acts injuriously in greatly aggravating the floods, which are often most destructive to the upper lands; on the prevention of which I reported to the Marquis of Westminster, and proposed lowering the weir at least five feet. Weir.

The Dee Company were incorporated by Act of Parliament, it is believed, in the year 1732. They received powers to embank and possess the land on the estuary on condition that they kept up a 16-feet navigation to Chester. By a subsequent Act the depth was reduced to 15 feet. They accordingly proceeded to embank, turning the river aside by abrupt and injurious bends, and that embankment now extends to below Connah's Quay, 7½ miles from Chester, and encloses, it is believed, about 4,000 acres, and a large additional quantity is now becoming ready for inclosure. Embankment.

The part of the navigation to which my attention was specially directed by the Committee, and which was surveyed, is shown on the plans accompanying this Report. It may be divided into two compartments, both of which are navigated with difficulty; one compartment extending from Chester to the end of the Dee Company's embankment at Connah's Quay, and the other from Connah's Quay to Flint. The greatest deficiency and irregularity in depth is in the upper of these compartments where the currents have been distorted by the bends in the channel, and the groins or jetties which have been projected into it; while that below presents obstructions to shipping, chiefly on account of the tortuous and shifting nature of the channels. The channel of the Dee below Flint, although tortuous and like that of many other estuaries, liable to change its direction, is nevertheless at high water of sufficient depth for the largest class of merchant vessels. State of Navigation.

The improvements proposed as the result of the survey were, *first*, cutting and widening of the banks of the river at Chester. *Second*, inproving the towns below the Cheese-house, near Chester. *Third*, altering the line of wall at Connah's Quay, and *fourth*, extending a dwarf rubble causeway, three feet above low-water mark from the Barrel Perch to the Pentre Rock, a distance of two miles and 40 feet. Improvements proposed.

In connexion with these works, dredging the bottom was to be carried on, and these different works were estimated to be executed for the sum of 24,905*l.* 10*s.* 9*d.* in the course of 12 or 14 months, and a depth of 16 feet at high water of spring tides obtained. Twenty feet might be got for 20,000*l.* additional; in all, 44,905*l.* 10*s.* 9*d.*

Appendix.

No. 29.

No. 29.

Wells Harbour.—Case of Embankments.

"Your opinion is desired, whether embankments made as above stated, which totally stop the flow of the tidal waters into the creeks and channels and over the marshes, where they were wont to flow and reflow, for the keeping open and deepening the harbour and channels of the port of Wells, and in one of which creeks, before the first embankment, a navigation of boats was carried on, are not nuisances. And if you are of opinion they are, in what manner you would advise the traders and inhabitants of Wells, who would be so materially injured by the continuance of them, to proceed for getting them removed. And if the Commissioners under the Act should think it right for them to interest themselves in removing and abating the nuisances, have they power to apply any part of the monies, raised under the Act obtained in 1768, in pursuing such means as you shall advise?"

Copy of Serjeant Grose's Opinion, 31st January, 1778.

"I am of opinion, that all the embankments, which, by preventing the flow and reflow of the tides, stop up the harbour, and are prejudicial to the navigation, were nuisances at the time they were made; but some of them have existed so long that there will be some difficulty in getting them removed; the best way to attempt it will be by indicting those persons who have made or continued the last of the embankments which are prejudicial to the harbour. It would be of too dangerous a consequence, I think, to attempt to abate them, by pulling them down, because the mischief might be infinite, and might be prejudicial against those who endeavour to remove the nuisance. I think the Commissioners, under the Act for preserving the harbour, by virtue of that clause which enables them to do what they think fit for the purpose of improving and maintaining it, may apply as much of the money raised under the Act in support of such a prosecution will, in my opinion, be doing that, which will assist to improve and maintain the harbour; but before such indictment is preferred, or anything done towards removing the embankments, I would recommend an application to be made to the lord of the manor, stating the inconveniences occasioned by the embankments, and begging him to remove them. If he sees the application in its proper light, I think he may find out some plan to remove the nuisance complained of, without doing much injury to the land embanked, which would be the most desirable object on both sides."

Result, 1779 to 1784.

"It appears that three trials took place in the Court of King's Bench, and that two verdicts were found for the Commissioners. On the last trial, the Court allowed for costs and expenses 562*l.*, which was paid by the representatives of Sir John Turner. An injunction which had been granted by the Court of Chancery, in 1781, restraining them from removing the banks, was dissolved, and they were at liberty to throw down the same. After these proceedings, it appears by a minute, that the water upon a spring tide flowed as far as the ancient limits of the port, by which we may infer, that the banks were all removed.

"The first indictment was preferred by the Commissioners of Wells Harbour, against Sir John Turner, and tried at the summer assizes at Norwich, 1779. Verdict found by the jury to be 'a nuisance.' This indictment was afterwards removed into the King's Bench, and intended to be tried at Norwich, but prevented by the death of Sir John Turner. It would appear subsequently from many remonstrances, that the trustees of Sir John Turner, rather than allow the banks to be forcibly removed, (of which the Commissioners of the harbour gave notice,) consented to an action. And after two trials, before special juries of Norfolk, at Norwich, two verdicts were obtained. Those were confirmed by the Court of King's Bench. The leading counsel, George Hardinge; solicitor, Mr. Jones, of London. The periods between 1781 and 1784. The appeal to the Lord Chancellor was in 1781. Folkes, Bart., and Hales, plaintiffs, (trustees of Sir John Turner), and Harbour Commissioners of Wells, Scarlet and Brown, were defendants. Mr. Elliott, engineer. No report recorded.

"In 1839, Wells Harbour is in fair order. Several banks have been removed recently. A bank at a very heavy expense has been erected across the main creek, which has diverted the channel, by which means the water is retained for a longer period in the harbour, which provides plenty of backwater until the ensuing flood tide. Spring tides usually flow 11 feet at the quay.

"The harbour was deprived of the usual operation of the tides, by the embankments from 1758 until 1784, when they were removed. In 1839, the revenue of Wells Harbour was between 500*l.* and 600*l.* per annum."

No. 30.

No. 30.

Extract from a Report by Mr. C. Rand on Rye Harbour.

The blowing up of Scott's Float Sluice seems to have occasioned great alarm to the owners and occupiers of lands, supposed to be dependent on this sluice for their protection and security against the influx tide-water, and for the carrying off the common follow and downfall freshes of rain-water, thereby preventing an accumulation from overflowing and inundating the levels, or low lands, by either the salt or fresh water.

Invited to give an opinion upon the best mode of draining off, and securing in future the lands now under water, in consequence of this apparently disastrous affair, the loss of the sluice, I took a view of the levels and flooded lands, and of what had happened at Scott's Float; and from many observations, and being no stranger to the principles of action and power of the sluice at that place, as a security from inundation by the influx tide (salt water), or for the draining the levels of their incumbent flood-waters, I could not look upon its destruction in any other light than as likely to afford great relief to the long and most grievously oppressed lands above it; feeling at the same time the temporary inconvenience that must be sustained until proper embankments can be raised for their security, and which ought to be forthwith taken in hand; but to erect anything of the kind of the

demolished sluice* for permanent protection, would, I think, and hesitate not to say, be deviating largely from the purest and best principles of hydraulic engineering, and a libel upon common sense. (On or about the site of the late sluice, Government may be disposed, if applied to, to connect a public bridge with their military works.)

During many years of public employment (in the civil department of the Ordnance as surveyor) the duty of the service had frequently occasioned me to be at Rye, where I embraced every opportunity that offered of making observations to gain local, as well as general information on the state of the harbour at that place,† as well as the levels above noticed, so materially dependent upon a good outfall to sea, and having been permitted to employ my leisure in works of civil engineering, I had, during one of my professional visits at Rye, a drainage in hand of two large levels; one of which, in similarity of feature, and other general circumstances, much resembling the lands through which the Rother runs, and which lands I had often viewed with much concern at their not being better drained, the great impediment to which always appeared to me to be the injudiciously placing a sluice in the tide's-way, equally objectionable, as ineligible to the well draining the land, and ruinous to the free navigation of the river.

Having carefully viewed the levels immediately on the direct channel of the Rother, from and between the lands at Dixter's and Padeham, and the place of Scott's Float Sluice before-mentioned, and having noticed the soundings of the channel of the river, taken proper sections of the same, and the water-way at the several bridges, viewed particularly the state of the embankments, and obtained, from the best information I could get, the number of acres then (2nd November) under water, called the wet level, &c., I have no hesitation in offering an opinion, and of giving a decided preference to an open tide's-way river, as the best possible mode of draining the levels, and for the protection and security of all the lands from being injured by the sea-water or land freshes, to embank substantially, to a level not less than three feet above the line of the highest known tide or flood, and to introduce into such embankment a suitable number of the best-formed drain trunks (those at present on the river are of the worst construction), giving a clear foreland to the seat of the banks, of seven yards on each side of the river, to enlarge the passage of the water-way, to carry off great downfalls of rain.

It may be argued by favourers of the sluice scheme of drainage, that the tide's water cannot affect the lands above it, inasmuch as it will be kept back by the sluice-gates whilst the tide is running in. Granted; but such stop-gates tend to the silting up the bed of the river and harbour below, to the ultimate ruin of the drainage, whilst the whole body of the sluice acts as a mud-trap, to choke up the channel of the river above, which by the free influx and reflux perhaps of the tides alone, with the usual follow, would keep the channel at all times well scoured. But should there be a deficiency of power in this respect, the freshes running off to sea, through an uninterrupted channel, would effectually cleanse it, and maintain its bottom, to give the better action to the drain trunks placed in the embankments.

To adduce proofs in support of the open-river mode of draining, and the securing the lands by embankments, with proper out-fall drain trunks, would be to name all the best drained lands in England situate on tide rivers; and this mode of draining being adopted, has reclaimed and laid dry many thousands of acres in this county (Sussex) under my own immediate direction, which had been overflowed and oppressed for ages before the removal of sea-sluices placed in the tidesway.

And so perfect has the drainage been made, by adopting the above means, in one level of about 4000 acres, that in many places where sea birds used to resort at the time of their incubation, and where sometimes they would continue all the year round, among the swamps and bogs, fine crops of corn have grown, and continue to be produced; and the above lands may fairly be stated improved in their value nearly 200,000*l.*, on the expenditure of something less than 20,000*l.*, in carrying on the works of drainage, and improving the navigation.

For the above, and other equally substantial and scientific reasons, which might be brought in support of the arguments in favour of the open tide's-way mode of drainage, in preference to the stopping up so valuable a river and drain channel as the Rother is, by a sluice of any sort or size, I must beg again to offer it as my best opinion, resulting from experience, not only to recommend, but to urge the necessity of the tide's-way drainage as the best possible security for the land, independent of the benefit arising from an improved state of the navigation,—"To adopt the plan of embankments and drain trunks," and to abandon as erroneous in principle—as injurious in practice—and probably as much more expensive, every idea of the sluice scheme, which originally ought never to have been suffered to have been put down, and, it is presumed, cannot legally be maintained.‡

Lewes, 11th November, 1812. (Signed) C. RAND.

No. 31.

Extract from a Report of Mr. John Rennie, respecting Rye Harbour.

December 26, 1812.

By comparing the sections which Mr. Giles made of the Rother, from Scott's Float Sluice to the fish-market at Rye, in 1804, with those that he made in October last, it appears that by the destruction of Scott's Float Sluice, and the tide being in consequence allowed to flow up the channel of the Rother, a considerable increase of depth has taken place, not less than two feet. What additional depth may have been acquired from the fish-market at Rye to the harbour's mouth, I have no correct means of ascertaining; but it must be considerable. I am also informed that the levels which sew into the Rother below Scott's Float Sluice, have been greatly relieved by the increased depth of the river, and that the water passes from thence in much less time than it used to do while Scott's Float Sluice was in existence.

The facts above stated are exceedingly satisfactory, and clearly show the injury which is occasioned to harbours by the shutting of the tides out of their ancient channels, and by embanking the marshes

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* In the channel of the Rother.

† It was my usual practice, whenever my professional engagements called me, to notice and take minutes of all public works.

‡ Vide Dugdale's Report, River Rother, 22nd edit., 3rd, &c.

Appendix. No. 31.

and mudlands over which they used to flow; and proves, in a decided manner, the propriety of the opinion given to the Commissioners of Rye Harbour, by Mr. Jessop, and myself, in February, 1801, respecting this embankment of the marshes on each side of the said harbour, and which at that time seemed to be considered by the parties interested as a matter of little importance to the harbour itself. But although, as a general principle, the facts are incontrovertible, there are cases where this principle may be abandoned with propriety, and the question is, whether this is one of these cases?

It has already been stated, that since Scott's Float Sluice was blown up, and the tide-water admitted freely into the Rother, that the channel, from the ruins of the said sluice to sea, has been deepened, and the sewage of the levels below the sluice materially improved; and I have no doubt, if things are allowed to remain in their present state, a further improvement will still take place.

No. 32.

No. 32.

Extracts from the Report of Mr. Daniel Alexander, on Rye Harbour.

November 18, 1813.

In obedience to your instructions, communicated to me by Mr. Francis Hickes, I put everything aside, and repaired to Rye, in company with him, on the 15th June last, and took the low and the high waters of the 16th and 17th of that month, being the 2nd and 3rd days after the full moon, to make a survey of the harbour of Rye, from the low-water mark up to Newenden Bridge.

Rye Harbour being a question which had employed the best consideration of the public for a long time past, I was favoured, by Mr. Weston's kindness and assiduity, with the various historical papers following, viz.:—

A Report of 1698, condemning all projects of improvement, "as the old (eastern) harbour, they say, is reduced to two or four feet water at low water; and is lost."

Ditto of 1719, suggesting the widening of the new (westernmost) channel, and taking away the dams or sluices, which prevent the flow of the tide.

An Act of Parliament, 1722, directing the dams to be opened.

Ditto, 1723, abandoning (after much controversy) that plan, and substituting a new (westernmost) channel for the harbour.

A Report, 1743, stating progress made, but doubting whether, when made, the new (western) harbour will be so good as the old one.

A Report, 1763, by Mr. Smeaton, containing plans for perfecting the new (western) harbour.

An Act, 1764, adopting Smeaton's plan.

Ditto, 1778, that plan having entirely failed, making alterations in the plan.

Ditto, 1797, repealing all former Acts, discontinuing the new (western) harbour altogether, and substituting a little work to be done in the old (eastern) harbour.

A Report, 1812, made by Mr. Rand to the Commissioners of the harbour, after the blowing-up of Scott's Flat Sluice, proposing the method of embanking, for the better draining the land, and deepening the old harbour, too.

And a Report, 1812, made by Mr. Rennie to the Commissioners of Sewers, of two methods for securing and draining the levels, one of which methods applies to the harbour.

It will shorten what I have to remark, if I here state once for all, that by "Collins's Coasting Survey," a work of esteemed authority, in 1683, the old (eastern) harbour of Rye was capable of accommodating vessels drawing from 12 to 14 feet, afloat at low water, and with a fair channel to sea; although I am of opinion, that if these soundings are correct, they were taken many years before Collins's time; because the decrease of water could not have been so sudden, in so few years, as stated in the next paragraph.

That then, and subsequently up to 1698, "the encroachments (I quote a sentence of the Report of 1698) on the tidal waters and innings of the lands upwards in the country, had almost entirely shut out the sea, so as to cause the harbour to be almost entirely lost, with a continued bar of not more than 2 to 4 feet at low water."

That the plan or project of 1718–19, went (with other works) to remove the dams or sluices; which removal was, by an Act of 1723, hindered from being put into execution. That in consequence of such non-removal, it was found, in 1743, that the new (western) harbour would not probably be better than the old (eastern) one.

That Mr. Smeaton's plan, in 1763, for perfecting the new (western) harbour, completely failed, owing to his not removing the dams, and on the contrary proposing additional dams or sluices, and so preventing the influx and reflux of the tide; and also, by his running out works on the western side of the entrance to prevent the fulls (which are large banks of shingle thrown up by the south-westerly winds all along this coast) from coming down from the westward. These fulls have long since covered up everything which he then did, and have filled up that outlet of the river, and reduced the harbour, which Rye now possesses, merely to the old (or eastern) harbour.

That in September, 1812, Scot's Flat Sluice or dam, was accidentally blown up; by which means about 600 acres of land, in different levels, were, for a certain time, destroyed (as to yielding any produce) by the overflow of salt water; and by which, in a very few months, the river above and below Scot's Flat, became much cleansed and deepened, and the harbour, too, deepened in a very considerable degree, and all the levels below Scot's Flat much better drained, to an extent I am told of 26,000 acres; while the part injured amounted, as above, to only 600 acres, forming part of the upper levels, containing about 4,000 acres altogether.

That the recommendation of Mr. Rand, is, to remove all dams in the tideway, and embank the river by marsh walls to above high water spring tides,

That Mr. Rennie reports in principle the same, but with reference only to the removing the evil from the 600 acres of drowned lands, which case only was referred to him by the Commissioners of Sewers; and that this embanking system, involving the deepening the harbour as its certain beneficial consequence, would cost 30,000*l.*, and the restoring the dam and sluice 20,000*l.*, leaving the Commissioners to choose which scheme they would adopt, and determine accordingly. And, finally, that the Commissioners of Sewers adopted the dam and sluice, and in April last begun the same, in consequence of which the harbour is now rapidly silting up again.

Thus the history of Rye Harbour, for nearly two centuries, has been a question of balance of value between the nautical point of a harbour, and the agricultural one of the low lands, near it, in which the latter has encroached on and annihilated the former, as far as the existence of any competent harbour goes.

It would appear to me that a harbour, such as it was in Collins's time, would be effected in the site of the present or old harbour, if the quantity of land then subject to be overflowed by the tides, was again laid open to the sea; and that it cannot be accomplished by any other means. The question then is, what benefit, considering the low lands already embanked to remain so, can be effected by other means.

Now I have no hesitation in saying, from a careful review of the circumstances, that the most perfect drainage of all the low lands both above and below Scott's Flat, and of deepening the harbour, that can now be effected, would be, by removing all dams or sluices across the tideway, and by giving the flood and ebb of all tides a perpetual and unrestricted current.

The whole district of low lands on each side of the Thames and Medway (which are prodigiously extensive and valuable, and are, many parts of them, many more feet lower below high-water mark than any of these lands near Rye and the Rother are) is all drained by an uninterrupted natural sewage, to as near low water as may be, through the banks or marsh walls next the tidesway, and without any dams whatever to obstruct the tide therein. This observation opens the way for the embanking proposition of Mr. Rennie, proposed also originally by Mr. Rand; which is very properly designed and stated in Mr. Rennie's Report, as amounting in estimate to 27,000*l*, and which, to effect any permanent improvement in the harbour, must still be executed, notwithstanding all the money expended in Scot's Flat; for this, in regard to the harbour, is money thrown away; and in regard to the drainage of the up country, not so good as the embanking: but under regulations (as it is executed) it might be made at times subservient to the purposes of the harbour, though it ought never to have been put up for that purpose.

In addition to this embankment it would be necessary to lay down certain inclined jetties or groins of low wicker or fascine work, to confine, restrict, and direct the channel of the river, below the town, into much narrower limits than it now occupies, and by consequence increase the depth of water, and shorten the passage from sea up to the town—and these I estimate at 2,500*l*. These wicker works should always be kept highest in point of level at the sea end of them, in order to cause what comes in with the flood to sew out from the Forelands, behind the said wicker work, at a point as far up the harbour as possible, and thus increase the column of water which shall every side flow through and down the channel.

Also to carry on and continue the present foot wharfing and wicker work along the eastern bank of the channel, as far towards low water as may be; so as to occasion the forelands east of the said channel to swarve up behind it, in order to confine the ebb tide into a narrower width, and thereby deepen the channel accordingly; and with this view I would particularly recommend, if nothing more was ever done, that the finishing the foot wharf and wicker work now in hand, should be carried out as far as possible. I estimate this at about 2,000*l*. more Though the greater the length when executed, the more expense and the more benefit.

Another subject of some import, is, that I would propose to embank all the salts south of the town, by cutting away the margins next the river, to as low as may be between high water neaps and low water neaps, throwing parts of the excavated matter up to form the said embankment, so as to prevent the sea overflowing these salts; and leaving the seaward parts (which I will call forelands) to be covered at every tide, with the flood to run out on the ebb and add to the scour every tide; and this daily effect to be in lieu of the small quantity of water, which now covers these salts, a very shallow depth, at the top of the high spring tides; the run of which, therefore, is only at the very gentle turn of the tiptop of the tide, is consequently soon over, and has therefore very little effect.

The expense of this, I apprehend, will be paid by the land gained, and the benefits be very considerable to the harbour, so that this object may be said to cost nothing.

There is a salt marsh, close under the town, to the eastward, on which, at the least expense I have ever seen, a wet dock might be made, to keep shipping of considerable draft afloat at low water, to load and unload to any extent, with perfect security to trade and the revenne; although this is an object of comparatively future consideration, yet it is proper here to mention it; about 9000*l*. would effect this.

Thus Rye Harbour may be improved, and its channel kept clear, in 3 feet to 4 feet water at low water, with a spring tide of 20 feet to 22 feet, and the neaps of 12 feet to 14 feet at the following cost:—

1st.	By discontinuing the use of, or by the removal of Scott's Float Sluice, and by embanking and other works above it	£27,000
2nd.	Groins below the town to direct and confine the channel . . .	2,500
3rd.	Wicker works towards low water	2,000
4th.	Embanking salts, and excavation of forelands, for overflow of neap tides.	—
		£31,500
5th	A wet dock at a future period	£9,000

Rye, at present, is a tidal harbour; accessible to ships of moderate draft of water upon the flood, and from and after half tide, which tides are favourable to navigation in the bay, being without any cross set, occasioned by the projection of Dungeness to the south-east.

South and south-westerly winds cause a heavy sea on the western side of the entrance of the harbour. If the harbour was so far restored as to give 14 to 16 feet draft of water at half tide, vessels of good draft might get into safety in the harbour, secure from all winds, and lie afloat, at low water, in a wet dock, made close to the town, very convenient to commerce and revenue; but it would be difficult to get to sea again with the wind from east-south-east, round to west, unless the weather was moderate.

Transports, the general average of merchant-men, and the smaller classes of ships of war, taken short with a contrary wind, might find shelter in Rye; but, under these circumstances, it would hardly be a port for a convoy, or a fleet to run to, except from the enemy's cruisers; for they, as well as ships of war on the Dungeness station, might find shelter without going into Rye from easterly

Appendix. —— No. 32.

gales, when bound eastward, under the west of Dungeness, where there is excellent anchorage; a well as also on the contrary from westerly gales, in the road under the east of Dungeness; and in southerly gales of wind, which bring the enemy out of his ports, men of war would choose to keep to sea, except when they want to refit.

As Rye lies in a bay, almost three miles to leeward (in most prevailing winds), of a line from Fairlight Point to Dungeness, it has occurred to me, that the great object to the town and port of Rye, and all the up-country connected therewith, as well as to the kingdom at large (for there is no good harbour from Portsmouth to the Downs), would be to render the port of Rye a weather harbour, by running the course of the Rother along the Flats south of Winchelsea, and so out to sea just under the eastward of Fairlight Point; but I have not looked at the country or coast, except on the charts, with this particular view.

Finally, looking at Rye commercially as a port, if restored as above, it is to be recollected, that from this port great quantities of oak timber and plank are shipped for the navy and merchants' service; as also bark, wool, hops, and corn, all drawn from the wealds of Kent and Sussex, of which the river Rother is the natural outlet: and as the Rother is navigable to Bodiam Bridge, so it is the receiver, through Rye, of all the coals, lime, stone, and shingle, for roads used a great way up the country, and for the extension of which navigation, through Robertsbridge, Etchingham, Ticehurst, and Mayfield, application to Parliament is now making; in addition whereto the navigation, for which an Act has passed to join the rivers Rother and Medway, will enable a constant communication between London and the British Channel, through the port of Rye direct, in a south-westerly direction, without going, as now, easterly, southerly, and westerly, with so many winds required up channel, round and about the South and North Forelands, and up the Thames.

I have the honour to be, Gentlemen,
Your most obedient Servant,
(Signed) Daniel Alexander.

No. 33.

No. 33.

Report of Mr. Cubitt on Rye Harbour.

London, April 17th, 1839.

Having been called upon by letters from Mr. Manser of the 28th of January last and subsequently, to inspect the harbour of Rye, with a view to my reporting upon the works that may be required for its improvement, I have now the honour to submit to the Commissioners this Report upon the subject; premising that I went down to Rye on Thursday last, the 11th instant, and devoted the two following days to a survey or inspection of the harbour and works, and making such examinations and inquiries relative thereto, as I deemed necessary to the execution of the duty required of me.

Adverting to my former Report of July, 1833, it will be seen that I then recommended certain works to be done within the harbour, that is, above the entrance at the old Pier Head; such as straightening and deepening the river's course, taking off bends, diverting the flood and ebb streams into a uniform channel, &c.; together with some slight works of reparation at the harbour entrance, both on the eastern and western sides thereof: but leaving the great question of permanent works between the harbour entrance at the pier and the low-water mark at sea, until some future opportunity, after the works of embankment, &c., under the then new Act of Parliament, should have been completed.

Since that time, however, little or nothing appears to have been done towards deepening, altering, or improving the river channel, which remains very nearly in the same state it was six years ago, except being a little worse; but the circumstances at the mouth of the harbour are very much changed since that time; the whole of the piling or groyne works are removed, and the mass of beach or shingle which was accumulated behind them is gone; a considerable length of a rubble stone pier or breakwater has been erected from the old pier head in a direction south-half-east to the extent of 1500 feet, at a height of 10 feet above low-water, so that on the whole, the harbour entrance is certainly improved in appearance, and is in my judgment certainly better than it was in 1833, but whether this improvement be wholly owing to the eastern works which have been erected, or whether other circumstances may not have contributed to its improvement is a matter of doubt, inasmuch as it appears that during the interval, about 400 acres of land within the fulls, have been embanked off from the tides, and thereby lessened the indraught and range of the surf at high and raging tides, which had a great tendency to bring shingle to, and even into the mouth of the harbour; it is my opinion that this circumstance has had its due share in the improvement of the harbour, and that good would arise if the tides could at any reasonable expense be kept entirely out of the main fulls.

As regards the main question which has so long agitated the minds of many persons interested in the improvement of this harbour, and in either case as I believe with an equally sincere wish for its improvement, by those who advocated either of the methods proposed, viz., whether eastern or western works were best as a general principle of improvement to the harbour? I can state this much, that in my judgment the harbour may be improved, and a straight channel formed and maintained from the pier head across the sands to the sea, by means of either eastern or western works, with different degrees of efficiency and different amounts of cost; but as one method has been already adopted and carried out to some extent, and with apparently good effects, I have no hesitation in strongly recommending that the continuation of the east stone breakwater be steadily and constantly persevered with in short lengths, so as to give time for the current to excavate the foundations, in turning round its end to the eastward, as the work proceeds, and that it be carried on at its present height, till such time as the low-water channel will take a straight course into the sea in the same direction as the breakwater, and which in my opinion will not be till the end of the breakwater comes as near the sea line of low-water as the last bend of the channel is, where the stream takes a southerly course into the sea. What this absolute distance may be, I am unable to state (from there being no survey or plan of this harbour in possession of the Commissioners, a deficiency which I did hope, from the strong representation relative thereto made in my former Report, would have been obviated before this time), but which distance I imagine may be about 3000 to 4000 feet from the present end of the breakwater.

Now taking the part already done to be about 1200 feet of efficient breakwater, at a cost of 3100*l.*,

it would, by the rule of proportion, cost 10,333*l.*, in the nearest round number, to complete 4000 feet; and which at an expenditure of 1000*l.* per annum, would complete the work to that extent in the eleventh year from the time of its commencement, or, in other words, 1000*l.* per annum would serve to add about 388 feet yearly to the breakwater, more or less, according to circumstances.

I mention the sum of 1000*l.* per annum, from having understood that about that sum will probably be available for harbour improvements, after defraying current expenses; but that, or even a smaller sum, uniformly and properly expended, will, at no distant date, prove the utility and efficiency of an eastern breakwater, for preserving a direct low-water entrance channel across the sands of Rye Bay to the harbour, so that the latter may be accessible from the sea during the night, by a single pair of leading lights.

With regard to other and minor improvements in the harbour, its channels, quays, &c., many might be suggested, but without a plan to lay them down upon, it is almost useless to enter upon the subject, inasmuch as no written directions for works of this kind, without a plan, can be understood in their details. I can only therefore recommend generally, that if the means offer an opportunity, it would be advisable to deepen the Dandy Channel to the level of low water, and then stop the channel by Stag's Hole, at or near its upper end, by which means the ebb stream (as well as the flood) would take that course, and the navigation be very much improved; besides which, a more effectual scour would obtain, and any accumulation of beach be prevented at the mouth of and inside the harbour.

Many other improvements might also be gradually made in the river channel, both at and below the town, particularly in the very inconvenient bend near Brede Sluice, and again at the mouth of the old river channel below, all which should be marked down with definite lines and dimensions, on a good plan and could then at any future time be gradually carried out, as the wants and means of the harbour might require or afford.

Having thus touched upon the principal points connected with the improvement of this port, I may perhaps be allowed in connexion therewith, to make a few observations as to the best mode of carrying such improvements into effect.

Hitherto it has been the custom (as I am given to understand) for individual Commissioners or members of a Committee to undertake the direction and management of the harbour works, or certain portions thereof, according to his or their notions; sometimes by erecting works west of the harbour entrance, and sometimes east, as the case might be.

Now this mode of proceeding is in my judgment extremely represhenible, it is unbusinesslike, it tends to promote animosities between individual members of the Commission. who may each be actuated by equally priseworthy and honest motives in advocating his favorite plan; it tends also to the waste and misapplication of the funds, without fixing any proper responsibility, and is moreover below the dignity of such an important Commission, to have their works carried on in such an unusual manner.

I therefore take the liberty of most strongly recommending the Commissioners, as a first and most effectual step to their improvement, to have the whole of the executive part of their proceedings put upon a better system, by laying down a fixed plan of improvements, and appointing a responsible officer as resident engineer (or expenditor, as I believe the local term is), to see to carrying the harbour works of all kinds into effect, who should receive his instruction from, and be accountable to, the body of Commissioners only, or a committee of works to be by them appointed, and over whom no individual Commissioner should have any controul, or of the works under his charge; by pursuing such a plan as this, under proper rules and regulations, I have no doubt unanimity would prevail, money be saved, the improvements be expedited, and the town and port of Rye, together with the sewage draining out through the same, be all greatly benefited; and also, that within the short space of from seven to ten years, there may be a direct channel from the sea into Rye Harbour, and a very much improved navigation up to the quays, and town of Rye.

W. CUBITT.

No. 34.

Extract from Mr. John Rennie's Evidence before the Rochester Bridge Committee in 1820.

Q. Then would not any obstruction, such as a weir or a dam across the river, have a tendency to prevent that injury at that part of the river where such weir or dam is placed?—Quite the reverse (if it is a tide river), for although it obstructs the water in running down from the interior of the country, yet it obstructs the tide-water from flowing up; and by obstructing the tide-water from flowing up, it prevents that continual scour which takes place by the flowing and ebbing of the tide. I can give the Committee a very strong fact to prove the truth of this observation; it happened about twelve or fourteen years ago, that I was employed to take a survey of the harbour of Rye in Sussex; that survey showed a very small depth of water from the sea up to a place called Scot's Float Sluice, which acted as a dam or weir to prevent the tide-water from flowing up. During the winter after that survey was taken, the sluice being in a very indifferent state of repair, was blown up by a land-fresh, and the tide of course was admitted to flow up the country as far as the level would admit. I was employed the year following to survey the same river again, and I found that during the winter in which the sluice was carried away, the river deepened nearly three feet.

"Rye Harbour has been ruined by embankments.s It appears in evidence in a law suit, 1837 (Lewis Duke of Newcastle and other Commissioners of Sewers *v.* the Commissioners of Rye Harbour, for cutting and removing a bank or weir), that formerly a 64-gun ship could use that harbour which is now ruined."

Chatham Dock, 20th January, 1818.

EXTRACTS from the Report of Mr. Rennie, to the Commissioners for revising the civil affairs of the Navy, 14th May, 1807:—

"I hold it to be a received opinion, that of the many causes which concur in the deterioration of rivers, the two following are the most prominent, viz.—

"First, Embankment of marhes, stopping of creeks, and all encroachments on the space over which the tide has formerly flowed, for, by diminishing the space to be filled in any given time, (which,

APPENDIX.

No. 34.

in this case, is the time of the flowing of the tide,) a proportionate diminution in velocity will ensue, and in the effect of the current in carrying off every sort of alluvial and other matters.

"The second cause to which I allude, is the contraction of the breadth of the principal channel, by partial dams, or by bridges built on starlings, similar to those of London and Rochester."

"*London, February* 24, 1801.

"The first plain and abstract question, 'whether the embanking salt marshes, overflowed by the tides and discharging their waters through a harbour, may be prejudicial to such harbour?' we feel no difficulty in answering. We consider that the magnitude of every tide harbour, both as to width and depth, is generally proportionate to the quantity of such flowing and reflowing water; and every subtraction from such quantity by embankment, tends to decrease the magnitude of the outlet to the harbour, and applied to the case in question, though a considerable quantity of fresh water flows through the harbour of Rye, it bears but a small proportion, especially in summer, to the quantity of salt water.

"That the giving up the marshes for embankment will be giving up a great natural agent, which, with other aids, might be made greatly to improve the harbour; that any other aids, without this agent, will only operate to keep it in good repair as a smaller harbour."

"JOHN RENNIE.
—— JESSUP."

No. 35.

No. 35.

Mr. Airy on Wexford Harbour.

In stating to the Tidal Harbours Commission my opinion regarding the measures proper for the improvement of Wexford Harbour, I think it right to state the sources of my information upon the condition of that harbour. I have no personal acquaintance with Wexford, but I have carefully read the Reports of Sir John Rennie, (1831), Mr. M'Call, (1837), Mr. Cubitt, (1838), Captain Vetch, (1841), and Mr. Rendel, (1844), as well as Captain Frazer's letter, (1845). But above all, I have diligently studied Captain Frazer's admirable chart, (1843). I have no doubt that, after examination of these documents, and careful reflection upon them, I am much better acquainted with the state of the harbour than I possibly could have been from any personal inspection.

It is not my intention to criticise in order the Reports to which I have alluded. I shall have occasion, however, to remark specially upon Mr. M'Call's proposal, and generally upon the recommendations which appear in some other Reports.

Referring, then, generally to Captain Frazer's chart, I shall proceed to notice the most remarkable circumstances of Wexford Harbour.

The first extraordinary circumstance is the relation of the extent of the harbour to the width of its entrance. The length of the basin, north and south, exceeds 8 miles; the average breadth (including in our estimation of extent the smaller basin above the town of Wexford) is perhaps nearly 3 miles. The whole tidal surface is, therefore, about 24 square miles, and the whole of this is filled and emptied at the same tide. The width of the entrance is less than half a mile. Consequently, the discharge is the same as if there were a river of the same width as the entrance, but 50 miles long, to be filled and emptied at every tide.

I think it probable, that in no other harbour in the world is the "equivalent channel" so long as in this. The rise of water in spring tides is about 6 feet. If, then, the average depth at the entrance were 12 feet, the length of the column of water to be run out in 6 hours would be 25 miles, implying a maximum velocity of about 6 miles per hour. It is evident that this is sufficient to tear up the bottom at the entrance of the harbour very rapidly, (unless it were rocky; it is, in fact, clay and gravel), and to increase the depth enormously, until it becomes so great, that from the increase of section thus produced the current will be less rapid.

The second extraordinary circumstance is the relation of the depths of water, at and near to the entrance of the harbour. In the channels within the harbour, the depth (at low water) is 6 to 9 feet. In the narrowest part of the entrance it suddenly deepens to 50 feet, and then immediately on the outside it shoals again, till, (I believe) in no place whatever is there a passage with more than 8 feet depth. This state of bar continues for half a mile or a mile, (to different distances in different directions), and the depth then gradually approximates to that of the neighbouring sea, north and south of the harbour.

The connexion between the second circumstance and the first is obvious. The enormous tidal current has scooped out the entrance of the harbour to a great depth, and the matter thus disturbed has deposited itself on the bottom of the sea at the smallest distance at which the motion of the water was sufficiently slow to allow it to rest. The effect of the tidal current has been precisely the same as if a dredging machine had been employed to dredge the entrance very deep, and to discharge all the matter so raised within a mile of the entrance.

It fortunately happens that the form of the Wexford Basin enables us to illustrate this action in various degrees. Above the town of Wexford there is a small tidal basin, with a surface of about 2 square miles. The channels in this small basin are 12 to 18 feet deep; the depth at the entrance of this small basin (opposite Wexford) is 19 to 26 feet; below Wexford, at the same distance from the entrance of this small basin as the distance of the exterior bar from the entrance of the great basin, it becomes 10 feet; and afterwards 5 or 6, in the centre of the wide expanse of the harbour. It is evident, here, that the small basin has produced an effect analogous in kind to that of the great basin, but smaller in degree; it has not scooped its entrance so deep, and has not deposited the matter so heavily immediately beyond that entrance.

Some of the engineers, in the Reports to which I have referred, have recommended, with a view to the improvement of the passage over the exterior bar, that the currents of the ebb from the great basin should be so directed as to act with even greater force at the entrance than they do at present. As regards this special instance, I have only to remark, that this amounts to the same as recommending that, when one dredging machine is found to be impeding the approach, by deepening the entrance and depositing the raised matter all round the entrance, another dredging machine should be placed,

so as to double the injurious effect of the first. But, as regards the effect of such tidal currents in general, I think it proper to express my opinion, that a great mistake has frequently been committed by engineers, in supposing that a rapid efflux is necessarily beneficial to the entrance of a harbour. When the entrance is narrow, the action of the sea always tends to spread the sand and shingle across it, so as to form a line continuous with the bank on both sides of the entrance; and, to keep that entrance clear for navigation, it is indispensable to have such an efflux as will be capable of bursting through such a line of sand or shingle. But in such instances as that of Wexford we have an efflux probably 50 times as great as is necessary for that purpose, and the effect of such a great efflux, as I have said above, is purely injurious.

I conceive, therefore, that it is perfectly certain that the first great step to the improvement of the entrance of Wexford Harbour must be *the contraction of the tidal surface of the great basin.* I cannot say how much ought to be left; but I should suppose that if four square miles were left, in addition to the smaller basin, that extent would be amply sufficient for keeping the entrance deep, without raising a bar on the outside.

Supposing this determined on, the next consideration would be, what steps should be taken to secure a deep channel outside the entrance? Should a channel be dredged from the present entrance through the bar? or should a new entrance be cut from the large basin into the deeper water north or south of the bar, the contracting works of the basin being directed accordingly? And if the latter, where ought the new entrance to be?

I imagine that the cross tide would very soon fill up any channel which should be cut through the bar. I shall therefore proceed to the consideration of an alteration of the entrance; and first, I shall remark on the plan proposed by Mr. M'Call.

Mr. M'Call's plan, as I understand it, was to cut a channel from the town of Wexford, nearly straight, in a south-easterly direction, through the mud of the great basin, and through the cliffs, to the bay south of the bar. As regards the inclosure of a great proportion of the basin, and the forming a new entrance in a part that appears liable to no objection on the score of external approach, I assent entirely to the general principle of this plan. But there is one objection to it which has not been remarked by the engineers who have commented upon it, but which, nevertheless, is, in my judgment, indisputable. The proposed new channel would make such an angle with the channel which passes the quays of Wexford, that Wexford would be left upon a point of land with the channel bending round it. The consequence of this would infallibly be, that the whole scouring power of the channel would be turned upon the opposite or concave side of the channel, and the quays at Wexford would very soon be blocked up with mud. (A similar injury has been produced at Lynn, by the change of a river channel). This would be an evil so serious, that I conceive that Mr. M'Call's plan must, on that ground, be at once laid aside.

Considering it, then, absolutely necessary, for the interests of the quays at Wexford, that the existing bend of the channel to the east, immediately after passing Wexford, be preserved, I imagine that the only feasible plan which can be proposed is the following:—The eastern reach of the channel extending from Wexford is to be preserved in its present form, and the north-eastern reach which follows it is also to be preserved and to be continued a little way till it reaches the angle of Big Island. Here the channel, instead of turning to the south-east, as at present, is to be turned to the east, and, passing close to the Breast Island and Little Breast Island, is to be carried through the burrows into the sea. It would be preferable, if possible, to carry the channel a little farther north than I have mentioned; and if there is no difficulty in removing the small islands, it would be best to carry the channel through the place where these islands at present stand. The old entrance must be stopped, and all parts of the basin not specified above must be embanked.

The channel would thus enter into much deeper water than that of the South Bay, to which Mr. M'Call's proposed channel leads.

The course of the sea-tides exterior to the harbour and bar appears to be what I believe is usually called "tide-and-half-tide." And the effect appears to be, what may be anticipated in such circumstances, that there is no decided tendency to incline the mouth of the entrance-channel either to the north or to the south. I expect, therefore, that a new entrance would nearly retain the position that should be given to it, without any particular tendency to incline the direction of its mouth.

The works for the plan which I have proposed would be much less than those for Mr. M'Call's plan. But whether their expense would be too great to admit of their practicability I am entirely unable to judge.

G. B. AIRY.

Royal Observatory, Greenwich,
21st July, 1845.

No. 36.

A SUMMARY of the ANNUAL INCOME of the various Ports of the United Kingdom, as derived from the Returns to the Order of the House of Commons, in compliance with the Address to the Throne of the 29th July, 1844. (Mr. *Hume.*)

England	£525,000 (approximate)
Scotland	176,000
Ireland	93,000
Total . . .	£794,000

No. 37.

The following works have been presented to the Commission:—

Mr. Meryon. . . .	On the Port of Rye.
Mr. D. Stevenson, C.E.	On an Instrument to measure the Force of a Wave.
Mr. Scott Russell, C.E.	Report on Waves, read to the British Association in 1844.
Mr. Stead	Book of Engineers' Reports, and others, on Harbours.

Appendix.

No. 38.

No. 38.

Report on the Quantity of Silt held in suspension by the stream in Dover Bay in February, 1845.

Sir, *Dover, 1st March*, 1845.

In obedience to their Lordships' directions of the 4th ultimo, to proceed to Dover and make experiments on the deposit of silt, &c., and to report the result of my observations with as little delay as possible, I have now the honour to enclose a Journal recording, in a tabular form, the observations made on this subject during the past month of February.

These observations have been made at all times of tide, and in the various states of wind and weather, and generally in the fair stream of the channel tide at about three-quarters of a mile off shore —that is in the line of the southern breakwater of the harbour proposed by the Harbour of Refuge Commission of 1844, as shown in the accompanying chart of Dover Bay.

A few samples of water have also been taken from Dover Inner Harbour; from Folkestone to the west, and from Ramsgate to the east.

For the sake of more ready comparison, I have reduced the results to the proportion of the number of grains of silt suspended in a cubic foot of water; and which may be seen on inspection by merely running the eye down the last column of the annexed Journal. The experiments were generally made upon upwards of two gallons of water.

The *maximum* quantity of suspended matter in Dover Bay was found at high water spring tides, in a strong off-shore wind at N.N.W., when as much as 473 grains per cubic foot of water were carried along by a tide stream running at the rate of 2½ knots an hour.

The *minimum* quantity observed was on a calm day, at slack-water, when 11 grains only were found.

The average quantity of matter borne by the stream, if we include the extreme cases, amounts to 51½ grains; and rejecting the extreme cases (which I have no doubt is nearer the truth) to $33\frac{8}{10}$ths per cubic foot.

Yet there is no permanent deposit in Dover Bay; it is manifest, therefore, that if any take place, the returning stream carries it away.

In the event of a close harbour, with only one entrance, being constructed in Dover Bay, we may imagine it to fill and empty, with the tide, like a basin; the upper portion of the water, or all within the range of tide, would be changed twice in the 24 hours, or, more correctly, 704 times in a year. Now, the mean range of tide here is 15 feet and if we suppose the whole of the water brought in to bear the average amount of silt, and the whole to be deposited (which is an extreme case) the quantity, at 51½ grains per cubic foot, would amount to 77½ lbs., or, at $33\frac{8}{10}$ grains to 51 lbs. per annum on each square foot of surface. A cubic foot of silt, we find from experiment, weighs 103 lbs., the former quantity, therefore, would be equal to 9 inches, the latter to 6 inches in depth of solid deposit annually over the whole surface.

From the known nature of fluids we cannot suppose water heavily charged with silt to remain outside a close harbour, and not press to diffuse itself throughout the mass of lighter water within, and as at all times there would be a column of 45 feet, or three times the depth of the tide, (in addition to the tide itself at high water,) thus pressing for entrance, the further deposit from this cause must not be overlooked, although I am not prepared to say that it would be anything of importance.

Although this amount of suspended matter seems large, there is reason to believe that an equal or greater quantity will be found along the whole of this coast.

In Ramsgate Harbour, to the eastward, with an area of 42 acres, the deposit is 2 feet in depth a year; at Folkestone, to the west, with an area of 14 acres, it is the same. In Dover Harbour, with an area of 28 acres, there is every reason to believe it is quite as much. This is, perhaps, not more than might have been expected in small artificial close harbours, where fully one-half of the matter brought in by each tide is deposited; nor, indeed, are these extreme cases; at Hull the deposit at the entrance of the docks is, I am told, as much as 7 feet in depth a year, and at Liverpool and Bristol probably even more.

But the most remarkable increase of sand on this coast is in Dungeness East Bay. There the "Roar," or "Newcome Sand" has extended considerably towards the Ness; the low water mark has moved outwards over a space one-seventh of a mile average breadth, by upwards of 3 miles in length, during the last 35 years;* where in 1809 were 2 fathoms water, we have found *dry sand;* and where the chart of 1809 gives 10 *fathoms*, we have found 10 *feet;* but omitting for the present all calculations, based merely on the shoaling of the water, we have (in addition to nearly as much shingle) an increase of 430 acres of *dry sand*, averaging 2½ yards in depth, equal to a mass of 5 million cubic yards, or 7 million tons of deposit in 35 years; and this without any artificial construction.

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* It appears that since the erection of Dungeness Lighthouse in 1792,† the Ness has advanced seaward about 121 yards; or, at the rate of 7 feet a-year. This would hardly seem sufficient to account for the great increase of sand in the East Bay. Since the date of the former survey in 1809, the "Swallow Bank," which lies about 2 miles off shore in the East Bay has materially decreased.

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† Dungeness Lighthouse was rebuilt in 1792, at 600 yards nearer the shore than its old site, and, as we learn from an inscription in the lighthouse, at 100 yards distance from the sea (whether at high or low water is not stated, but we will assume the latter). The date of the erection of the old building is not known; but, from Jeake's Charter of the Cinque Ports, written in 1678 (page 124), it is conjectured that it was built in the time of James the First—say 1603. Supposing that the old lighthouse was erected at the same distance from the sea as the present one, that is, 100 yards, it would give us 7 feet 10 inches as the annual rate of increase of the point during 190 years.

Now, from actual survey of Dungeness Point made in Her Majesty's ship "Blazer," in November, 1844, we find that the distance from the centre of the lighthouse to low-water mark of ordinary spring tides is 221 yards; consequently, if, as stated above, the present lighthouse was built in 1792, at 100 yards from the sea, it is manifest that the Ness has advanced seaward 121 yards, or at the rate of 7 feet a-year for the last 52 years. This is certainly a remarkable coincidence.

The distance from the beach to the present limit of shingle, in going northwards towards Lydd, the nearest town, is about 5800 yards; and supposing the shingle to have increased rather more rapidly at first, or at an average rate of 3 yards a-year, this distance will carry us back 1900 years; or, speaking generally, we may imagine the sea to have bathed the foot of the present limit of verdure about the commencement of the Christian era.

With respect to the *rate* of stream that will bear a certain quantity of matter in suspension, it is not easy to try any experiments below the surface, for want of proper instruments. It appears from the enclosed journal that a stream of 2½ knots held the largest amount of silt yet taken up, namely 473 grains per cubic foot, in suspension,—but we find also that a tide stream of half a knot carried 30 grains (the average amount) in suspension; and even at slack water on the surface, in a calm, we found from 20 to 30 grains suspended in a cubic foot of water; there was, probably, however, an under current in motion.

Hitherto I have found no means of measuring these sub-marine currents, which certainly exist, and differ from the surface current. Neither Massey's Patent Log, nor Clément's *Sillométre* are sensitive enough; Woltmann's "Hydrometric Fly" or Tachometer (used to measure the velocity of the Danube) seems the most likely instrument to accomplish it. I believe that such an instrument has been successfully used by the Messrs. Stevenson, C.E., on rivers in Scotland; by Raucourt, in measuring the velocity of the Neva near St. Petersburg, at a depth of 60 feet; by Defontaine, on the Rhine, and by Funk, in several rivers in Germany, but the only one, which, through the kindness of Mr. Turnbull, C.E., I have been able to obtain, was out of order. I have heard, also, of a recent modification of this instrument by M. Aimé, of Algiers, now at Paris, and have written for an account of it. I purpose also trying a series of loaded floats to swim at each fathom depth, with a fine wire leading to the surface; but such observations require much better weather than the late inclement season, during which my experiments have been carried on.

I should have stated that, from an analysis by Mr. Phillips, of the Museum of Economic Geology, the silt at Dover is composed one half of fine sand, quarter of chalk, and quarter of vegetable matter.

With respect to the time required to deposit, further experiments are necessary; but from some trials in tall glass jars, I found that in still water fully one half of the particles (all the sand) dropped to the bottom in a few seconds.

May I add a few words on shingle? From observations I have been enabled to make recently on the travelling of shingle, there seems good reason to believe that if its progress cannot be entirely arrested, at any rate it can be carried off into deep water, and so fall harmless. At Folkestone, since Mr. Turnbull, the resident engineer, has run out a groyne into 8 feet water, no shingle has come into the harbour. Since the explosion by Mr. Cubitt at Round Down Cliff, the passage of the shingle has been so completely arrested, that the works near the Dover Terminus of the South-Eastern Railway are in danger for want of the usual supply; and the resident engineer has been compelled to protect them by a series of long and costly groynes.

I do not recollect any instance in which I have found shingle below low-water mark; I am aware that many differ from me in this opinion, and the subject is well worthy of careful investigation. Even at 50 yards only from the steep beach off the pitch of Dungeness our anchor, armed with a dredge or scoop, only brought up mud. Nor am I aware of any instance of shingle having crept round a groyne the outer end of which was maintained in 6 feet depth of water. If this be the case, shingle may be arrested when we please.

In conclusion, I may, perhaps, be permitted to say, that nothing has arisen in the course of these experiments to cause any doubt in my mind as to the eligibility of Dover Bay for the construction of a large harbour of refuge and defence. Whether the plan of a close harbour, with a large southern entrance, as proposed by the Harbour Commission of last year, be adopted, (and the non-deposit of silt in Kingstown Harbour, in Dublin Bay, is much in favour of such a plan,) or, if it be preferred, to endeavour to keep a current through the harbour, and thus prevent deposit; in either case I should not fear the result. Give but the eastern and western piers a fair slant with the set of the tide stream, and carry them out into the deep water, which is close at hand; let our most eminent engineers consult as to the best mode of constructing the outer parts of those piers, either on arches, or in detached masses, or in some manner, (if such be thought desirable,) so as to ensure a stream of not less than a knot an hour, throughout the harbour, and there will be little to fear either from shingle or silt; which two evils it must never be forgotten are *not* peculiar to Dover alone, but are common to, and equal in amount at, Dungeness, and every part of the south-eastern coast of England.

I am, &c.,

(Signed) JOHN WASHINGTON, *Captain.*

To the Secretary of the Admiralty.

P.S.—I am indebted to Lieut.-Col. Colquhoun, of the Royal Artillery, for much useful advice in conducting these experiments. Also to Captain Peat, R.N., of the Coast Guard, and to the Commanders of the Revenue Cruisers; to Captain Mercer, R.N., and the officers of the Packet Service generally; to Captain Martin, Harbour Master at Ramsgate, Lieut. Worthington, R.N., Lieut. Radcliffe, R.A., and Mr. G. Turnbull, Resident Civil Engineer; but especially to Lieut. Chestney Simmons, R.N., who in addition to his coast guard duties, has devoted the greater part of every day during the past month in assisting me with much zeal and intelligence.

SILT JOURNAL.

No. of the Observation.	Date. — 1845.	Wind. Direction.	Wind. Force.	Weather, and State of Sea.	Time of High Water. A.M.	Time of High Water. P.M.	At which Sample of Water was taken up. Hour of the Day or Night. A.M.	Hour of the Day or Night. P.M.	Time of Tide.	Tide Stream at Surface. Direction.	Tide Stream at Surface. Rate.	Soundings, in fathoms, at Low Water.	Depth below Surface, in Feet.	Height above Ground, in Feet.	Locality.	Quantity of Water examined, in Cubic Inches.	Matter Suspended, in Grains.	Proportion of Silt, per Cubic Foot, in Grains.	Remarks, &c.
					H. M.	H. M.	H. M.	H. M.			Knots.								
1	Feb. 3	W.S.W.	7	Fresh breeze and much swell.	7 21	8 1		1 0	¾ ebb . .	S.W.	1	6	18	34	Dover Bay . .	138½	1·5	18·7	The water was taken up just within the line of the Southern Breakwater, proposed by the Harbour Commission of 1844, in the fair stream of the channel tide at about ¾ of a mile off shore.
2	4	N.E.	8	,, ,,	8 39	9 11	11 45		½ ebb . .	N.E.	½	7	18	30	,, . .	138½	3·0	37·4	
3	5	S.W.	7	,, ,,	9 41	10 10		Noon.	,, . .	,,	1	6	6	38	,, . .	138½	2·0	24·9	
4	5	,,	7	,, ,,	,,	,,		0 5	,, . .	,,	1	6	Surface.	44	,, . .	138½	2·5	31·2	
5	6	N.	7	,, ,,	10 36	11 1	11 45		¼ ebb . .	,,	1½	7	18	36	,, . .	138½	4·7	58·4	
6	6	,,	7	,, ,,	,,	,,	11 50		,, . .	,,	1½	7	Surface.	54	,, . .	138½	19·0	235·0	1728 cubic inches = 1 cubic foot.
7	7	N.N.W.	7	,, ,,	11 30	11 50	11 30		High water.	,,	2½	5	9	40	,, . .	..			6¼ gallons = 1 cube foot.
8	7	,,	7	,, ,,	,,	,,	11 35		,,	,,	2½	6	20	34	,, . .	138½	38·1	473·4	
9	8	S.E.	6	,, ,,	,,	0 12		Noon.	,,	,,	3	5	6	42	,, . .	138½	28·9	360·0	Specific gravity of this water 1026·05, at a temperature of 60° Fah. from several experiments.
10	8	,,	6	,, ,,	,,	,,		0 5	,,	,,	3	5	20	28	,, . .	..	7·5	93·5	
11	13	S.W.	7	Heavy swell and sea.	3 12	3 29	11 30		⅓ flood . .	Slack	water.	2	Surface.	18	In the bight of the bay.	566	28·0	85·5	
12	14	N.	5	Fine weather—slight swell.	3 51	4 12		0 30	,, . .	,,	,,	3½	,,	24	,, ,,	..			
13	14	,,	5	,, ,,	,,	,,	,,	0 45	½ flood .	S.W.	1½	7	,,	48	On line of Southern Breakwater.	338	8·15	41·6	
14	14	,,	5	,, ,,	,,	,,		1 0	,, . .	,,	1½	7	42	8	,, ,,	178½	5·75	55·6	Rise of tide, 19 feet on springs.
15	14	,,	5	,, ,,	,,	,,		5 40	¼ ebb . .	N.E.	1½	7	Surface.	54	,, ,,	358	6·75	32·58	,, 11 feet on neaps.
16	14	,,	5	,, ,,	,,	,,		6 0	,, . .	,,	1½	7	18	36	,, ,,	360	10·0	48·0	
17	20	N.E.	3	Fine weather at close of a strong N.E. wind.	9 58	10 20	11 15		,, . .	,,	1½	Dry .	Surface.	18	In Dover Outer Harbour.	675	3·50	8·96	The stream of tide runs for 4 hours to the N.E. after it is high water at Dover Pier, and *vice versâ*.
18	20	,,	3	,, ,,	,,	,,	11 20		,, . .	,,	1½	,, .	18	1	,, ,,	735	15·30	35·97	
19	20	Calm.	3	,, ,,	,,	,,		Noon.	⅓ ebb . .	,,	1	7	Surface.	54	Dover Bay . .	667	16·0	41·45	
20	20	,,	3	,, ,,	,,	,,		0 5	,, . .	,,	1	7	42	12	,, . .	348	9·25	45·93	
21	20	,,	3	,, ,,	,,	,,		3 0	¾ ebb . .	S.W.	1	7	Surface.	48	,, . .	593	3·60	10·47	
22	20	,,	3	,, ,,	..	..	..	3 25	,, . .	,,	1	7	6	42	,, . .	554	8·0	25·0	
23	20	,,	3	,, ,,	..	..	..	3 23	,, . .	,,	1	7	12	36	,, . .	573	13·0	39·20	The rate of the tide—
24	20	,,	3	,, ,,	..	..	..	3 20	,, . .	,,	1	7	18	30	,, . .	563	12·70	38·98	On springs . . 3½ miles,
25	20	,,	3	,, ,,	..	..	..	3 18	,, . .	,,	1	7	24	24	,, . .	527	11·0	36·07	On neaps . . 2 miles;
26	20	,,	3	,, ,,	..	..	..	3 14	,, . .	,,	1	7	30	18	,, . .	546	11·80	37·35	and it sits fairly along shore, both on the flood and on the ebb.
27	20	,,	3	,, ,,	..	..	..	3 10	,, . .	,,	1	7	36	12	,, . .	615	19·80	55·63	
28	21	S.W.	3	Moderate and fine—smooth water.	10 37	10 56	11 45		¼ ebb . .	N.E.	1	Dry .	Surface.	16	Dover Harbour.	602	3·8	10·90	
29	21	,,	3	,, ,,	,,	,,	,,		,, . .	,,	1	,, .	15	1	,, .	614	11·45	32·22	
30	21	,,	3	A light swell .	10 37	10 56		1 30	½ ebb . .	,,	½	7	Surface.	52	Dover Bay . .	670	5·0	12·90	

31	21	,,	3	,,	,,	,,	,,	,,	,,	,,	½	7	6	46	,,	609	4·5	12·76	
32	21	,,	3	,,	,,	,,	1 35	,,	,,	,,	½	7	12	40	,,	600	5·25	14·95	
33	21	,,	3	,,	,,	,,	,,	,,	,,	,,	½	7	24	28	,,	602	5·50	15·79	
34	21	,,	3	,,	,,	,,	1 40	,,	,,	,,	½	7	36	16	,,	Lost.			
35	Feb. 20	N.E.	3	Moderate and fine —sea smooth.	9 58	10 20	11 15		¼ ebb			1	Surface.	20	Ramsgate Harbour.	372	10·50	48·10	In outer Harbour.
36	20	,,	3	,, ,,	,,	,,	,,	,,	,,	,,	½	1	18	2	,, ,,	364	7·0	33·30	
37	21	W.S.W.	3	,, ,,	10 37	10 56	10 40		High water.	,,	½	1	Surface.	20	,, ,,	375	9·25	46·27	
38	21	,,	3	,, ,,	,,	,,	,,	,,	,,	,,	½	1	18	2	,, ,,	337	4·5	23·08	
39	22	Calm.	..	Calm and fine	11 15	11 34	Noon.		¼ ebb			Dry	Surface.	12	Folkstone Harbour	338	2·0	10·22	A fresh S.S.E. wind during the night.
40	22	,,	..	,,	,,	,,	,,	,,	,,	,,	½	,,	12	1	,, ,,	346	4·0	20·0	
41	25	S.S.W.	1	Light winds — smooth sea.	0 50	1 10	11 25		⅔ flood			,,	Surface.	15	Dover Harbour	580	11·75	35·0	
42	25	,,	1	,, ,,	,,	,,		3 25	⅓ ebb			,,		15	,,	634	4·0	10·90	
43	25	,,	1	,, ,,	,,	,,	11 35		⅔ flood	Slack	water.	7½	,,	56	Dover Bay	677	4·25	10·85	At southern entrance of proposed harbour.
44	25	,,	1	,, ,,	,,	,,		0 35	,,	,,	,,	7½	18	38	,,	641	14·50	39·09	
45	25	,,	1	,, ,,	,,	,,		0 30	¾ flood	N.E.	1½	7½	42	14	,,	Lost.			
46	25	,,	1	,, ,,	,,	,,	11 40		,,	Slack	water.	7½	54	2	,,	655	10·2	26·76	
47	25	S.W.	1	Moderate breezes and slight swell.	,,	,,		3 35	⅓ ebb	N.E.	2	7½	Surface.	56	,,	608	7·50	21·31	
48	25	,,	1	,, ,,	,,	,,		3 50	,,	,,	2	7½	9	47	,,	646	12·75	34·10	
49	25	,,	1	,, ,,	,,	,,	,,	3 45	,,	,,	2	7½	18	38	,,	655	9·75	25·57	
50	25	,,	1	,, ,,	,,	,,	,,	3 43	,,	,,	2	7½	30	26	,,	648	11·0	29·33	
51	25	,,	1	,, ,,	,,	,,	,,	3 40	,,	,,	2	7½	42	14	,,	670	13·90	35·85	
52	25	,,	1	,, ,,	,,	,,	,,	3 38	,,	,,	2	7½	54	2	,,	650	14·50	38·54	
53	26	N.W.	7	Strong breeze and heavy sea.	1 27	1 46	11 30		½ flood	S.W.	½	7	Surface.	50	,,	355	6·0	29·20	Strong breeze from S.W. during the past night.
54	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	12	38	,,	350	5·50	27·15	
55	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	24	26	,,	353	5·25	25·70	
56	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	36	14	,,	280	3·50	21·60	
57	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	42	8	,,	250	5·75	39·74	
58	27	W.	1	Light winds and smooth water.	2 6	2 27	Noon.		½ flood	Slack	water.	7½	Surface.	56	,,	672	7·75	19·92	Placed a platform 8 feet square on the bottom near the north pier in the Outer Harbour.
59	27	,,	1	,, ,,	,,	,,	,,	0 5	,,	,,	,,	7½	9	8	,,	675	4·50	11·52	
60	27	,,	1	,, ,,	,,	,,	,,	0 10	,,	,,	,,	7½	18	38	,,	655	5·0	13·10	
61	27	,,	1	,, ,,	,,	,,	,,	0 15	,,	,,	,,	7½	30	26	,,	582	3·75	11·13	
62	27	,,	1	,, ,,	,,	,,	,,	0 20	,,	,,	,,	7½	42	14	,,	662	5·50	14·35	
63	27	,,	1	,, ,,	,,	,,	,,	0 25	,,	,,	,,	7½	54	2	,,	565	5·25	16·06	
64	27	,,	1	,, ,,	,,	,,	,,	0 35	,,	,,	,,	7½	Surface.	6	,,	695	13·75	34·18	
65	28	S.E.	7	Strong breeze and much swell.	2 48	3 13	9 55		Low water.	S.W.	2	7	,,	44	,,	655	11·25	29·68	Strong wind rose about 11 P.M. yesterday evening.
66	28	,,	7	,, ,,	..	..	10 0		,,	,,	2	7	9	36	,,	640	21·0	56·70	
67	28	,,	7	,, ,,	..	..	10 5		,,	,,	2	7	18	26	,,	625	10·75	29·72	
68	28	,,	7	,, ,,	..	..	10 10		,,	,,	2	7	30	14	,,	540	10·50	33·60	
69	28	,,	7	,, ,,	..	..		2 0	⅔ flood			Dry	Surface.	12	Dover Harbour	680	20·75	52·73	Between the piers.
70	28	,,	7	,, ,,	..	..		2 3	,,			,,	9	3	,,	615	25·25	70·94	

Dover, March 1, 1845.

JOHN WASHINGTON, *Captain.*

SILT JOURNAL.

The following Experiments were made alone by Lieut. Chestney Simmons, R.N. :—

No. of the Observation.	Date. — 1845.	Wind. Direction.	Wind. Force.	Weather, and State of Sea.	Time of High Water. A.M.	Time of High Water. P.M.	At which Sample of Water was taken up. Hour of the Day or Night. A.M.	Hour of the Day or Night. P.M.	Time of Tide.	Tide Stream at Surface. Direction.	Tide Stream at Surface. Rate.	Soundings, in fathoms, at Low Water.	Depth below Surface, in Feet.	Height above Ground, in Feet.	Locality.	Quantity of Water examined, in Cubic Inches.	Matter Suspended, in Grains,	Proportion of Silt per Cubic Foot, in Grains.	Remarks, &c.
					H. M.	H. M.	H. M.	H. M.			Knots.								
77	Mar. 5	E. by S.	..	Moderate breeze —sea tolerably smooth.	8 29	9 1	,,		Low water.	W.S.W.	2	7½	Surface.	45	Dover Bay, Long Mark. — The Hugh Light on with a green patch in the cliff to the eastward, of a circular slope in the same.	685	5·50	13·87	
78	5	,,	..	,, ,,	,,	,,	,,	3 45	,,	,,	2	7½	6	39			Lost.		
79	5	,,	..	,, ,,	,,	,,	,,	to	,,	,,	2	7½	12	33		685	6·50	16·39	
80	5	,,	..	,, ,,	,,	,,	,,	4 6	,,	,,	2	7½	18	27		675	8·50	21·76	
81	5	,,	..	,, ,,	,,	,,	,,		,,	,,	2	7½	24	21		685	6·75	17·02	
82	5	,,	..	,, ,,	,,	,,	,,		,,	,,	2	7½	30	15		695	5·	13·43	
83	5	,,	..	,, ,,	,,	,,	,,		,,	,,	2	7½	36	9		665	5·25	13·64	
84	Mar. 11	N.	..	Strong breezes —sea agitated and rolling swell from the E.S.E.; water thick and discoloured.	0 48	1 6		..	Near ½ flood.	W.S.W.	2	7½	Surface.	45	First Thwart Mark. —The low tree at the back of the Castle, just visible, gradually drifting to St. Mary's church in the low part of the valley.	672	12·50	32·14	
85	11	,,	..	,, ,,	,,	,,	9 55	..	,,	,,	2	7½	6	39		680	16·	42·13	
86	11	,,	..	,, ,,	,,	,,	to	..	,,	,,	2	7½	12	33		660	21·25	55·62	
87	11	,,	..	,, ,,	,,	,,	10 13	..	,,	,,	2	7½	18	27		677	18·00	45·94	
88	11	,,	..	,, ,,	,,	,,		..	,,	,,	2	7½	24	21		677	18·25	46·56	
89	11	,,	..	,, ,,	,,	,,		..	,,	,,	2	7½	30	15		675	18·	46·08	
90	11	,,	..	,, ,,	,,	,,		..	,,	,,	2	7½	42	3		375	10·	46·08	
91	12	North.	..	Fresh breezes and snow; sea in the similar state as yesterday.	1 25	1 43		,,	Last ¼ . .	W.S.W.	2	7½	Surface.	45	,, ,,	690	9·50	23·79	
92	12	,,	..	,, ,,	,,	,,	6 45	,,	Ebb . .	,,	2	7½	6	29	,, ,,	675	14·25	36·48	
93	12	,,	..	,, ,,	,,	,,	to	,,	,, . .	,,	2	7½	12	33	,, ,,	672	16·25	41·78	
94	12	,,	..	,, ,,	,,	,,	7 5	,,	,, . .	,,	2	7½	18	27	,, ,,	678	18·0	48·82	
95	12	,,	..	,, ,,	,,	,,		,,	,, . .	,,	2	7½	24	21	,, ,,	685	6·0	15·13	
96	12	,,	..	,, ,,	,,	,,		,,	,, . .	,,	2	7½	30	15	,, ,,	680	31·25	79·41	
97	12	,,	..	,, ,,	,,	,,		,,	,, . .	,,	2	7½	42	3	,, ,,	680	21·50	54·63	

98	20	N. by W. ..	Strong breezes—sea smooth and fine clear water.	8 37	9 3	,,		Low water.	W.S.W.	2½	7½	Surface.	45	Marks as above.	670	11·0	28·37		
99	20	,, ..	,, ,,	,,	,,	,,	3 20	Ebb . .	,,	2½	7½	6	39	,, ,,	670	11·75	30·30		
100	20	,, ..	,, ,,	,,	,,	,,	to	,, . .	,,	2½	7½	12	33	,, ,,	675	13·25	33·92		
101	20	,, ..	,, ,,	,,	,,	,,	3 42	,, . .	,,	2½	7½	18	27	,, ,,	665	15·0	38·97		
102	20	,, ..	,, ,,	,,	,,	,,		,, . .	,,	2½	7½	24	21	,, ,,	672	13·0	33·27		
103	20	,, ..	,, ,,	,,	,,	,,		,, . .	,,	2½	7½	30	15	,, ,,	652	15·50	41·07		
104	20	,, ..	,, ,,	,,	,,	,,		,, . .	,,	2½	7½	42	11	,, ,,	680	15·35	38·75		
105	Apr. 3	East. ..	Light breezes and fine; sea very smooth.	8 13	8 42	,,		Low water.	W.S.W.	2½	8	Surface.	48	Marks as before.	683	7·0	17·71		
106	3	,, ..	,, ,,	,,	,,	,,	3 20	,,	,,	2½	8	6	42	Dover Bay . .	688	7·5	18·83		
107	3	,, ..	,, ,,	,,	,,	,,	to	,,	,,	2½	8	12	36	,, ,,	683	6·25	15·81		
108	3	,, ..	,, ,,	,,	,,	,,	3 47	,,	,,	2½	8	18	30	,, ,,	688	6·5	16·32		
109	3	,, ..	,, ,,	,,	,,	,,		,,	,,	2½	8	24	24	,, ,,	686	5·75	14·46		
110	3	,, ..	,, ,,	,,	,,	,,		,,	,,	2½	8	30	18	,, ,,	688	4·75	11·93		
111	3	,, ..	,, ,,	,,	,,	,,		,,	,,	2½	8	42	6	,, ,,	688	7·0	17·58		
112	24	Calm. ..	Cloudy — sea smooth, with muddy appearance.	,,	0 22	7 30	,,	,,	,,	3	14	18	66	Dover Castle, N.N.W.	680	10·75	27·31	Lieut. Scriven, R. N.	
113	24	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	3	14	36	48	Foreland Upper Light, N.E. by N.	680	12·0	30·49	,, ,,	
114	May 21	W.S.W. ..	Strong breezes and rain—sea rather rough.	10 21	10 48	,,	3 25	Ebb stream just making.	W.S.W.	Nil.	7½	Surface.	45	Marks same as 5th March.	682	2·	5·06		
115	21	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	,,	7½	6	39	,, ,,	685	5·	12·61		
116	21	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	,,	7½	12	33	Dover Bay . .	664	4·	10·40		
117	21	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	,,	7½	18	27	,, . .	662	2·5	6·52		
118	21	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	,,	7½	24	21	,, . .	655	3·25	8·57		
119	21	,, ..	,, ,,	,,	,,	,,	,,	,, . .	,,	,,	7½	30	15	,, . .	678	2·5	6·37		
120	21	,, ..	,, ,,	,,	,,	,,	,,	,, . .	,,	,,	7½	42	3	,, . .	666	4·0	10·37		
121	June 2	Calm. ..	Weather fine—sea perfectly smooth.	8 59	9 20	,,	3 0	Low water.	W.S.W.	1	7½	Surface.	45	Same marks .	576	1·75	5·25		
122	2	,, ..	,, ,,	,,	,,	,,	,,	Ebb . .	,,	1	7½	6	39	,, . .	576	1·5	4·5		
123	2	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	12	33	,, . .	576	1·5	4·5		
124	2	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	24	21	,, . .	576	3·75	11·25		
125	2	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	30	15	,, . .	576	1·5	4·5		
126	2	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	36	9	,, . .	576	2·0	6·0		
127	2	,, ..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	42	3	,, . .	576	2·25	6·75		
128	6	S.S.W. ..	Moderate breeze and fine—sea rather rough, and swell from S.S.W.	11 52	,,	,,		Slack water between half and last quarter ebb.	W.S.W.	1	8	Surface.	48	,, . .	576	3·75	11·25		
129	6	,, ..	,, ,,	,,	,,	,,	3 42	,,	,,	1	8	12	36	,, . .	576	5·75	17·25		
130	6	,, ..	,, ,,	,,	,,	,,	to	,,	,,	1	8	18	30	,, . .	576	4·75	14·25		
131	6	,, ..	,, ,,	,,	,,	,,	4 8	,,	,,	1	8	30	18	,, . .	576	5·0	15·0		
132	6	,, ..	,, ,,	,,	,,	,,		,,	,,	1	8	36	12	,, . .	576	6·5	19·5		
133	6	,, ..	,, ,,	,,	,,	,,		,,	,,	1	8	42	6	,, . .	576	Lost.			
134	6	,, ..	,, ,,	,,	,,	,,		,,	,,	1	8	42	6	,, . .	576	6·0	18·0		

SILT JOURNAL—*continued.*

No. of the Observation.	Date. — 1845.	Wind. Direction.	Wind. Force.	Weather, and State of Sea.	Time of High Water. A.M.	Time of High Water. P.M.	At which Sample of Water was taken up. Hour of the Day or Night. A.M.	Hour of the Day or Night. P.M.	Time of Tide.	Tide Stream. at Surface. Direction.	Tide Stream. at Surface. Rate.	Soundings, in fathoms, at Low Water	Depth below Surface, in Feet.	Height above Ground, in Feet.	Locality.	Quantity of Water examined, in Cubic Inches.	Matter Suspended, in Grains.	Proportion of Silt per Cubic Foot, in Grains.	Remarks, &c.
					H. M.	H. M.	H. M.	H. M.			Knots.								
135	26	North.	..	Moderate breezes and fine weather — swell from Eastward.	5 2	5 30	,,		Near half flood.	W.S.W.	½	7½	Surface.	45	Dover Bay, marks as before.	576	5·5	16·5	Water very clear; saw the bottle at the depth of 18 feet.
136	26	,,	..	,, ,,	,,	,,	,,	2 25 to 2 50	,,	,,	½	7½	6	39	,, ,,	576	1·5	4·5	
137	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	½	7½	12	33	,, ,,	576	1·5	4·5	
138	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	½	7½	18	27	,, ,,	576	1·5	4·5	
139	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	½	7½	24	21	,, ,,	576	1·5	4·5	
140	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	½	7½	30	15	,, ,,	576	1·75	5·25	
141	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	½	7½	42	3	,, ,,	576	2·0	6·0	
142	26	,,	..	Light breezes and fine weather—swell from the S.S.W.	3 47	4 10		,,	One hour past low water.	,,	1	7	Surface.	42	Dover Bay, marks as before.	576	4·25	12·75	Water thick; nothing visible below the surface.
143	26	,,	..	,, ,,	,,	,,	11 13 to 11 33	,,	,,	,,	1	7	6	36	,, ,,	576	5·75	17·25	
144	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7	12	30	,, ,,	576	6·0	18·0	
145	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7	18	24	,, ,,	576	6·25	18·75	
146	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7	24	18	,, ,,	576	7·5	22·5	
147	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7	30	12	,, ,,	576	5·5	16·5	
148	26	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7	36	6	,, ,,	576	7·5	22·5	
149	July 18	W.S.W.	..	Moderate, and fine weather.	9 43	10 19	,,		Last quarter ebb.	W.S.W.	1	7½	Surface.	45	Marks as above.	576	3·75	11·25	
150	18	,,	..	,, ,,	,,	,,	,,	3 15 to 3 42	,,	,,	1	7½	6	39	,, ,,	576	7·25	21·75	
151	18	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	12	33	,, ,,	576	9·50	28·50	
152	18	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	18	27	,, ,,	576	9·50	28·50	
153	18	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	24	21	,, ,,	576	6·75	20·25	
154	18	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	36	9	,, ,,	576	11·0	33·0	
155	18	,,	..	,, ,,	,,	,,	,,	,,	,,	,,	1	7½	42	3	,, ,,	576	10·25	30·75	
156	25	E.S.E.	..	Moderate and fine —sea smooth.	3 16	3 16	,,		High water.	E.N.E.	2	7½	Surface.	45	,, ,,	576	7·0	21·0	
157	25	,,	..	,, ,,	,,	,,	,,	3 10 to 3 30	..	..	2	7½	6	39	,, ,,	576	2·50	7·50	
158	25	,,	..	,, ,,	,,	,,	,,	,,	..	..	2	7½	12	33	,, ,,	576	3·0	9·0	
159	25	,,	..	,, ,,	,,	,,	,,	,,	..	..	2	7½	18	27	,, ,,	576	5·0	15·0	
160	25	,,	..	,, ,,	,,	,,	,,	,,	..	..	2	7½	24	21	,, ,,	576	5·25	15·75	
161	25	,,	..	,, ,,	,,	,,	,,	,,	..	..	2	7½	30	15	,, ,,	576	5·50	16·50	
162	25	,,	..	,, ,,	,,	,,	,,	,,	..	..	2	7½	36	9	,, ,,	576	4·75	14·25	

Dover, August 1, 1845.

CHESTNEY SIMMONS, *Lieut. R.N.*

ANALYSIS OF EVIDENCE.

BALD, WILLIAM, C. E., Resident Engineer on the Clyde, from 1839 to 1845 . . . . . p. 1
Cut a channel 100 yards wide and 6 feet deep through Port Glasgow Bank, 4——Also through the Puddle-deep and Garmoyle Banks about 2 feet; no tendency to silt up, 20——Deepened to 10 feet at low-water springs, 23——Gained 2½ feet depth of water at Glasgow, by which vessels drawing 17 feet water now come up to the Quay, 29——Made cuts at Dumbarton Bank and Long Dyke, 32——Rule to preserve a width of 100 yards at Glasgow, and 133 at mouth of river Cart, 6 miles below Glasgow, 39——Estimates expense of dredging the channel on south side of Newshot at 7000*l.*, 43——Recommends it to Clyde Trustees, 46——States it to be 100 yards shorter, to contain an area of 100 acres, and if cleared out would hold 34 millions of cubic feet of water, 46——A pier belonging to Mr. Henderson projects 150 yards into the river west of Newshot Isle, 50——The south channel is blocked up by a dyke, and will soon become meadow land, 51——To open it would be the greatest improvement to the river, 61——Rate of tidal wave from Port Glasgow to Bowling, 13 miles an hour, from Bowling to Clyde Bank only 6½ miles, and from Clyde Bank to Glasgow 10 miles an hour, 64——Attributed to the crooked north channel, and not to difference in depth, 65——Ordered to desist from pulling down a dyke, 77——The parallel dykes erected by the late John Rennie, 78——Removed a weir 3 feet high at Glasgow Bridge, 91——The weir at Stockwell-street Bridge stops considerably the flow of the tide upwards, 98——Spring tides flow above the Glasgow Water-works to about 4¼ miles above Glasgow, 102——If weir were removed 25 million cubic feet of tidal water would ascend 4 miles above Glasgow each tide, 105——Weir is necessary to support bridge, 106——Weir was made by Act of Parliament to sustain the level of low-water above bridge for the benefit of the Water-works Company, 127——If removed Glasgow need not be deprived of fresh water; the weir might be placed at Dalmarnock, 3 miles higher up at the limit of ordinary tides, 129——Need not cause damage to manufactures, &c., 132——Salt water only reaches Renfrew 6 miles below bridge, 136——Within the last six years has dredged about 1½ million cubic yards of stuff from bed of river, 138——The effect is great improvement in trade, 142——Present depth at Glasgow Quay at low-water 11 feet, and bottom soft, 146——A basin of 6½ acres capable of holding 60 ships has been proposed, 148——Owing to the porous nature of the ground there would be great difficulty in making it a wet dock; it would be better as a tidal basin with 15 feet at low-water, 149——Rise of tide at Glasgow Quay 6 feet 6 inches to 7 feet, 149——On the north side of river at Stobcross is good ground for a floating dock, 149——Such a basin might be puddled, 156——Clyde is too narrow; all the points between Glasgow and the Cart river should be cut off, 158——During the last two years witness has added 7¼ acres to the harbour; cut off point on north side from the Kelvin east; has given plans for cutting off at Over Newton, Fairfield, &c., 139——Considers it highly objectionable to lay soil dredged up on the alveus of the river, 162——The Clyde too important a river to the trade of the country to be left solely to local powers; it should have independent and superior control, 170——The Clyde Trust composed of 33 members, principally merchants, 172——Witness opposed the Union Railway Company who wished to lay rails down along the quays on the north side of the harbour, 182——It would be injurious to the foreign trade, 182——Attributes benefit on Clyde to dredging, 204——The oldest map of the Clyde is that of William Kyle, of Glasgow, in 1800; this shows 219 jetties begun in 1768 by Golborne; and the former alveus of the river, and therefore would show any present encroachments, 214——The river might be improved by removing obstructions, 219——At present there is a great deposit of silt in Glasgow Harbour, 80,000 cubic yards annually; at Bowling, 10 miles lower down, a bank of 60,000 cubic yards rises each year, 219——Ten feet depth of water in Newshot Isle, north channel, 224——The south channel should be cleaned out, and would be better, 226——Would lower the parallel dikes on the Clyde so as to be ¼ and ⅓-tide dikes, 245——Dikes are necessary to protect the banks of the river, but they should be so placed as not to obstruct the tidal flow, 252-3——Depth in Glasgow Harbour solely due to dredging, 254——Freshes rise at times 15 feet above low-water, or double a spring tide, 255——Removal of obstructions would drain the city better, 258——All the water-works and supply of water to the factories could be kept up if the weir were removed, 259——Mr. James Walker has been consulting engineer during the time witness has been resident engineer, but the plans have not been submitted to him, 260——Stockwell Bridge is said to be insecure, and is to be taken down, 266——Knows no reason why the funds of the Clyde Navigation Trust should aid in building a new bridge, 269——Strongly objects to another weir being placed across the river, 270——The weir was first caused by stones being thrown into the bed of river to protect old Glasgow Bridge; but not by Act of Parliament or any public authority, 274——It was then removed to Stockwell Bridge, and it is now proposed to remove it to 140 yards above Hutcheson's Bridge, 275——If water were taken from 2½ miles higher up the river there would be no occasion for a weir all, 276——And this would free the navigation up to Rutherglen, and be a great benefit, 278——In the year 1839 reported strongly in favour of the extension of the Clyde navigation upwards, 494——Quoted the evidence of Telford and Jardine to show that if the bed of the river at Dalmarnock be secured the weir may be taken away entirely, 496——But no attention was paid to his report, 497——Reported again in 1844 against peat being thrown into the streams Black Cart and Gryfe, 500-1——Every auxiliary stream should be kept open, 511——Suggested the working the dredging barges by steam, whereby 80,000 cubic yards of soil additional have been raised a year, 515——Suggested an iron diving-bell boat in order to remove boulders from the bed of the river, 516——In the year 1842 was ordered to desist from working the diving bell, 516——States the works he has carried out on Clyde or Bowling Basin of 14 acres; enlargement of Glasgow Harbour 7 acres, &c., 517——Boulders of whin-stone still in bed of Clyde, 526——Has lifted 1000 tons of boulders per year, some weighing 5 tons, 531-8

——Expense of dredging from 8*d.* to 12*d.* per cubic yard, 535——The soil is chiefly fine sand, and comes from the upper country, 541.

Witness has extended a pier at West Port; reported to Board of Works on the improvement of the rivers Boyne and Drogheda, 184——Plan published by Irish Board of Works, 189——Gave a plan also for improvement of the river Moy in west of Ireland, 194——Also planned a harbour in Tramore Bay, in south of Ireland; improvements on river Suir; and gave two plans for the improvement of Troon, 195——Opposed a dam across the river at Belfast; made plans and sections for improvement of river Foyle at Londonderry, 196——Gave evidence against the dikes near Newburgh on the Tay, 201——Local influences are prejudicial, Government should have control in all Harbour Trusts, 205–6——Landed proprietors have generally encroached, 208——Embankments to a large extent are proposed in Ireland; at Belfast 2500 acres; at Lough Swilly; and Lough Foyle, said to be 20,000 acres, 209——Has warned the Trustees of Londonderry against this encroachment, 211——Is of opinion that it would be injurious to enclose Jarrow Slake on the Tyne, 212——Is of opinion that all harbours should be under Government control, 228——Such is the system in France, where it works well, 233——The first and most useful thing would be to obtain accurate plans of all our ports, 238——It would be true economy on the part of Government to spend money on our ports, 241——Has been applied to to go to Rouen and report on the Seine, 243——As a general principle is of opinion that cutting off tributary streams or damming up creeks is objectionable, but exceptions may arise, as at Belfast, where it might be a benefit to cut a more direct channel to the sea, 546.

Stevenson, Alan, C. E., Engineer to the Northern Lights . . . . . p. 13

Has viewed the Tay, Forth, Ribble, Lune, and Dee, 283——Surveyed the Tay in 1833, principal obstructions to navigation were at Kirwhinnel Ford, at the entrance of the Earn, at Seggieden Ford, at Mill Hurst, and other fords, 286——Obstructions caused by 9 jetties on the south bank of the river, accumulating large quantities of gravel and mud, 290–295——Some jetties removed by process, 297–302——Jetty at Wemys removed on remonstrance, and mud bank dredged away, 308, 309——Dykes run out near Mugdrum Island, and at Nethermain's Island (the latter 333 yards long), with a view of forming land, 320–323——City of Perth is conservator of the river, from Perth to Invergowrie Burn, 3½ miles above Dundee, 316, 317——Pier of Cairnie shortened by order of the Tay Commissioners, 331——Cairns in the middle of the stream removed, 333——Materials deposited opposite Pitfour, 334——Impede the flow of the tide to Perth, but deepen the channel at Kirwhinnel, 337, 338——In 1834, depth at Mill Hurst Ford, at high-water spring-tides, 11–9 feet, at low water, 1–9 feet; in 1845, high water, 16 feet, low water, 4–9 feet, owing to the removal of the fords; tide also reaches Perth 55 minutes sooner, 340–360——There is now a depth of 15 feet at high water all the way to Perth, 360——Tide does not rise to a higher level than formerly, but bed of river is deepened, 360——Act for deepening river from Perth to Newburgh, obtained in 1834, 344——Has reported to Tay Commissioners that by dredging 850,000 tons more, a depth of nearly 20 feet might be obtained up to Perth, 363——Endeavours of landed proprietors to encroach on the banks of this river, the Lune and Ribble, such encroachments impediments to navigation; several proprietors are Commissioners, 365——Independent Commissioners necessary for the purpose of appeal, local Commissioners sometimes at variance with public interests, 367–382——Proposals of all changes or improvements should be submitted to a public Board having conservancy of rivers, 383——A local public officer to have plans, and to report, or check encroachments, 383–388——By proper embankments and removal of obstacles, the velocity of the tide and its scouring power might be increased, 390——Occasionally portion of tidal water may be excluded with advantage, 393——Velocity of tidal wave between Newburgh and Perth previous to improvements, 3·42 miles per hour, subsequently more than 5·13 miles, 395——Lights and buoys at mouth of Tay are in charge of the Trinity House, Dundee, 400, 401——Alteration in mouth of Tay; survey taken by order of Admiralty, 402——Tay drains 2,283 square miles of country, mean discharge, 220,000 cubic feet of water per minute; Earn discharges 54,959 cubic feet per minute, 403–409——Mr. Rennie says, Thames discharges 80,000 cubic feet per minute, 410——Soil dredged up from Tay in 5 years, 841,480 tons deposited at the back of Sleepless, Mill Hurst, and Balhepburn Island, 412——Tide reaches 2½ miles above Perth, 35 miles from sea, 418——Salt water extends a little above Mugdrum Island, which is 7½ miles below Perth, and 25 from mouth of river, 423——Jetties thrown out at Powgavie and Errol very detrimental; if completed, they would exclude 1,800 acres of tidal water, 428——The longest is half a mile long, 430——Proposed railway bridge at Mugdrum, if erected, would have destroyed navigation of Tay upwards, 436——No bridge should be permitted lower than Perth, if so low, 440——No evil apprehended from swing-bridge over the Earn, 443.

Has reported on the navigation of the Ribble, 444——Began to dredge there in 1838, 446——Six feet depth of water have been gained. Ribble will admit of deepening 20 feet up to Preston, 447——There are now 14 feet up to Preston Marsh, 449——Full 31,000 cubic yards of rock have been excavated by means of coffer-dams, 452——Dredging will be carried on, and a wall completed to direct the current, 458.

Has reported on the Lune leading to Lancaster, but for want of funds no works have yet been begun, 462——Lancaster, 6 miles from the sea; and if proposed works were carried out, a depth of 16 feet at high-water spring-tide would be obtained up to this town, 464——At present there are barely 13 feet over the fords, 465——The obstacles to be removed are Scale Ford, Baffler's Ford, Heaton Shoal, Colleway Shoal, 467–474——Depth of water at Glasson Dock at mouth of river, 25½ feet, 469——Rise of tide at Glasson, 21 feet, at Lancaster, 10 feet; the bed of the river rises 11 feet in 6 miles, 479——Is not aware that the Corporation of Lancaster have enclosed several hundred acres of land at Marsh Point, 486——Estimate of expense for obtaining 16 feet at high-water spring-tides to Lancaster, 7,425*l.*; to complete further improvements in widening and deepening the river, 5,775*l.* in addition; total 13,200*l.*—*Note.*

Walker, James, C. E., Consulting Engineer to Clyde Navigation Trust, and F.R.S. . . . . p. 24

The proposed weir on Clyde is to be placed on the level of low water in the river before improvements began, 590——Tide now falls out from 2 to 3 feet lower than formerly, 591——Tide flows feebly 2 miles above the proposed site for weir, 593——Depth of the Clyde at Glas-

gow does not depend upon the tide, but on the river freshes, 596——Every fresh carries away more soil than it brings down, 597——Rate of tide at Glasgow 1 mile, of a fresh 4½ miles, an hour, 599——Practically the weir in the Clyde does not impede improvements of the river, 601——Just below the weir is a gully of 15 feet depth, 602——Before the deepening of the river above bridge by the trustees, its bed was nearly dry, 602——If it could be done, is quite ready to take upon himself professionally the whole responsibility of removing the weir up to Dalmarnock, 603——By this the river near Glasgow would be materially improved; it would form a large basin, and would extend the harbour 2 miles higher up, 604, 605——If the weir were removed the river in a fresh might so scour the banks and bed, as to bring down Rutherglen Bridge, 608——Would wish anything done to increase the flow and ebb of the tide to the utmost, but the opposition would be too strong to attempt to carry such a measure now, 608——Has contemplated a plan for removing the weir, by having a pipe from Dalmarnock to the factories in the city, 614——Cranston Water-works might be united with the Glasgow Water-works, 614. If the change of channel could have been made completely from the north to the south side of Newshot Isle, it might have been desirable to do so, but under the circumstances it was wrong to begin such a work, as the weir could not keep two channels open, 642——Saw the resident engineer on that occasion, but as Rennie, Telford, and Logan, all preferred the north channel, he saw no sufficient reason to change it, 647——Since 1839, has been frequently consulted as to improvements, but not as to the mode of carrying out works, 674——Mr. Logan gave the lines of parallel dykes which have been slightly modified, 674——It would be mischievous to remove the dykes, or to widen to any great extent; Clyde has been more improved than any river in the world; in Smeaton's time, only 3 feet at high water at Glasgow Quay; but by the skill of Golborne, Rennie, and Telford, it has been brought to its present state; if Clyde had been made too wide at first, the present depth would not have been obtained, nor the consequent large revenue; by widening it now to nearly double the former width, great increase of dredging will be required, 675——Depth in upper part of river due to freshes; in the lower to tides; all the lower dykes should be half-tide dykes, 676——Considers it would be waste of money to close the channel north of Newshot Isle, and to open the south side, 683——The gain in distance would be 130 yards in 2 miles, 685——If the section of the south channel made by Mr. Aird be correct, the removal of half a mile of solid rock would cost ten times Mr. Bald's estimate, 686——There is a longitudinal section of the river from Glasgow to Greenock, 691——The removal of the weir at Glasgow Bridge has so deepened the river, that Stockwell Bridge is in danger of falling, and as the deepening is to go on, it seems fair that the river trustees should pay the additional expense, caused by founding the piers so much deeper, and by removing the weir 1100 yards higher up the stream, 694——Sir John M'Neil and witness reported that 8,100*l.* would be a fair sum to be paid for this purpose.

The Glasgow Junction Railway Company purpose to carry a line of rails across the Clyde upon two piers 15 feet wide, to be built in the middle of the river, at 16 yards below Glasgow Bridge; height of middle arch to be 35 feet above high water. The Glasgow Bridge has 6 piers, average 8½ feet wide, taking up 51 feet of the water-way, 2248——The railroad might cross quarter of a mile above Rutherglen Bridge.

Is not sure that it would be an advantage that Government should have the nomination of some of the trustees of a port. It is certainly desirable that all harbours should be improved as much as possible, to be of use in the event of war or bad weather.

Enumerates upwards of 60 harbours that he has examined and reported on; has not been able to lay down any general principles for improvements, each harbour must be treated *per se*. The upper parts of a river usually depend upon freshes, the lower part on the tidal scour. Whitby is a case which depends almost entirely upon land floods; the chief obstructions to the propagation of the tidal wave are irregularity of width and a contracted channel. Whitby is a case where the obstruction is entirely caused by the sand which is washed in from the sea. Judiciously narrowing and improving their depth is the best mode of dealing with rivers, 2754.

In Report on Thames of 1842 states that Barking Shelf is the worst in the river, and might be removed without difficulty: considers that it is much to be deplored that so important a measure as the removal of the several shoals in the river should, for the want of 60,000*l.*, be left untouched. The Report in 1843 enumerates 14 shoal places in the river, and that all might be removed, and witness has had no reason to alter his opinion; contemplates a uniform depth of 12 feet at low-water springs from London Bridge to Gravesend; dredging may be done at from 9*d.* to 1*s.* a cubic yard. Is of opinion that there should be one superintending power over all harbours to control all operations where navigation is concerned, 2770——Considers that local trustees, with proper professional advice, are the most likely persons to be vigilant conservators of their rivers; a general surveillance would be unobjectionable on public grounds, 2775. Is of opinion that there ought to be a plan of every harbour in the United Kingdom, but would not interfere with the present efficient system of the hydrographer, in having each port surveyed. There should be efficient conservancy over the harbours, but it will require great caution as to the party entrusted with the exercise of that power, 2782——Has reported that the embankments at Southwold Harbour are an evil, but it must not be supposed that in all cases the embanking of land is an evil. The Thames, for instance, was once six times its present width, and many thousand acres of marsh land have been taken from it with advantage, reserving always an adequate breadth for a channel, 2785——The evil in Southwold Harbour arises from the tidal estuary having been diminished, so as no longer to contain backwater to scour the harbour, 2786——No reason to suppose that the shoals at the mouth of the Thames have increased, or that they will increase, 2789——If the Penryn Dock were made, does not apprehend any danger of silting up in Falmouth Harbour. It would be advisable to call upon the parties to give security for the completion of the works, or for their removal. The balance is in favour of good being done by the proposed dock rather than evil, 2806——With respect to the improvement of the Thames, is of opinion, that a Commission should be formed, in which the different interests are represented; as the City of London, the Crown Lands, the Admiralty, and the Trinity House, and they should carry out the requisite improvements, while the two former bodies are at law, regarding the right of soil; has reason to believe that this would have been done, except for the change of Ministry. In the meantime the navigation of the Thames is neglected, and its commerce interrupted, 2810.

GRAY, CHARLES, Deputy Chairman, and TURNER, ANGUS, Secretary of the Clyde Trust . . p. 24
Act under 3 and 4 Vict., c. 118, 552——Smeaton, Golborne, Rennie, and Telford have been the engineers consulted on the Clyde, 553——Mr. J. Walker is now consulting engineer, 554——Meeting to oppose Glasgow Junction Railway, 570——Trustees are bound to maintain the level of the river on account of the water-works, 576——Old weir at Glasgow Bridge, the present one at Stockwell Bridge, 579——A Bill before Parliament to move weir 1100 yards higher up the river, 581——Could not at present be removed higher without injuring factories, 582——Water Company and two factories are secured by statute, 586——The trustees look forward to the possibility of ultimately removing all the weirs on the river, 618——Newshot Island south channel is straighter but rocky; would cost 8000*l.* to open; owners of property on the north side of the river would object to the north channel being shut up, 620——Proprietors of adjoining land claim the soil made by the dykes, 624——Clyde trustees have power to remove dykes which injure navigation, 626——There are clauses in the Act of 1840, which recognize the right of the land-owner to protection for his banks, 628——It may be a question whether, owing to lapse of time, the public may not have lost its rights to the south channel, 629——By Act of 1840, the trustees can take land, formerly the alveus of the river, on paying half its value, 631——In recent Act the Crown claims all property within the ancient alveus of the river, 632——The Woods and Forests have received 1,700*l.* as half price for such land since 1840, 632——These decisions virtually prove the rights of the public to all land formerly covered with the tidal flow, 633——The dyke in Newshot south channel is a half-tide dyke, and the Clyde trustees did not think its removal of sufficient consequence to navigation to go to law about it with the proprietor of the adjacent shore, 634——The resident engineer gave his opinion that it ought to be removed, and began to do so, but the trustees, acting under the advice of their consulting engineer, stopped it, 635–640——Does not consider the Clyde to have been materially improved since Mr. Bald became its engineer, 652——Cannot speak exactly as to increased depth, as the only soundings in the river that the trustees would be responsible for, were taken in 1839, 637——Mr. Bald was instructed by the Committee to deepen the Port Glasgow Bank, 659——Has no knowledge of the Board having forbidden the removal of boulder, 664——It appears from the Minute produced, that Mr. Spreull, the treasurer, did issue such an order, but he had no authority to do so, 668——Many Reports have been received from Mr. Bald, recommending improvements in the upper part of the river, 670——Mr. Walker has been consulted as to improvements within five years, but not as to the plan of carrying them out, 673——It is proposed that the Clyde Trust shall pay 8000*l.* towards erecting the Stockwell Bridge, upon condition of the piers being founded deep enough to admit of deepening Glasgow Harbour, 693——Foundations and weir at Stockwell Bridge strengthened a few years since; it was necessary to do so, as the Water Company complained of losing their water; and it was done by driving a row of piles across the river, under an order of the Court of Sessions, 695.

HINDE, RICHARD, ROBINSON, WILLIAM, and SHARPE, EDMUND, Lancaster Quay Commissioners p. 33
Authorised to appear on behalf of the Commission, 699——The recently proposed bridge over the Lune by the Lancaster and Carlisle Railway Company will cross 500 yards below the lowest existing bridge, 702——The town quays, with a depth of 2 feet water, extend below the proposed crossing; the bridge will be of two arches, fixed, and at a level of 32 feet above the quays, so that rigged vessels could not pass under, 708——The railway company offer 16,500*l.* compensation for wharfs, storehouses, &c., but nothing for improving navigation, 711——The quay will probably cost 10,000*l.*, 714——Occasionally vessels of 200 tons come up to the quay, 727——Of the two proposed railways considers the original one above the town would interfere least with navigation, 730——Vessels discharge at Lawson's wharf, 731——Tide reaches ¼ mile above the town to Skirton Locks, which obstruct the flow, 734——New bridge is built on five arches, which are so low, that no vessels can pass, 736——If bridge is permitted it will interfere with 500 yards of navigable harbour space, 741–743——At Scale Ford dredging took place in the Lune some years ago, 744——Consent given to the new line by the Quay Commissioners, on the ground of being more beneficial to the navigation, and the town generally, 745–752——Commissioners elected triennially, 748——Two piers will stand in the bed of the river, and occupy 24 feet of waterway, 755——Resolution at a public meeting of the inhabitants of Lancaster in favour of the new line, 757——New quays to be erected westward of intended viaduct, for the convenience of shipping, 760, 761——Of opinion that proposed railway bridge will be prejudicial to flow of tide, 769——The only compensation for injury done to the river would be by deepening the channel; length of channel 6 miles; bed of river at bridge 10 feet above low water mark, 771——Stevenson's Report of 1838, recommending the removal of shoals to obtain an additional depth of 4 feet in the whole course of the river, giving a depth of 16 feet at high water spring tides at Lancaster Quay; estimate 13,200*l.*; no funds to carry out such improvements, 777——Present greatest depth at spring tides, 12 feet; the commerce of the district requiring a depth of 20 feet at spring tides; but the expense of such improvement would be very great, 781——From the survey taken by Capt. Denham, it is the opinion of many of the Commissioners that the necessary improvements are unattainable, 783, 784——From Sunderland Point to mouth of river are large quantities of sand, the removal of which would create more expense than that of the obstructions in the river, 785——A plan was contemplated in 1795 to divert the course of river through the peninsula of land lying between Poulton Ring, in Morecambe Bay, and the Island Salt Area in the Lune, a distance of 2½ miles in length, almost even with the level of high-water mark, which would ensure a depth of 24 feet at low water, 786–789——Or we might retain the present river, and connect Lancaster by means of a railway, with docks constructed at Poulton Ring, 790——Docks at Glasson and the New Quay used by shipping unable to reach Lancaster or Preston, 793–797——Communicate with Lancaster by a branch of the Lancaster and Preston Canal, 798——Ships of 280 tons have reached Lancaster, 802——Of opinion that an additional 4 feet of water would not answer the purposes of the port or the expected increase of traffic, 808——Original sum demanded as compensation of railway company 25,000*l.*, of which 10,000*l.* was to be allotted for improving the navigation; is of opinion that all injury would be compensated by such improvements, 815——The majority of the Commissioners are connected with shipping or actual owners of vessels, 821——Is of opinion that the new Commission recently appointed is desirous of carrying out any improvement suggested by the Admiralty or other

authority, and that if the railway bridge be raised to permit ships of 100 tons burthen to have access to the present quays, the 16,500*l.* would be entirely available for the improvement of the harbour, 822, 823——Is of opinion that the bridge can be so raised consistently with the level of the railway for the sum of 7,500*l.* in addition to the present cost, 824, 825——The 16,500*l.* exceeds Mr. Stevenson's estimate of expense for making the river navigable for vessels of 16 feet, 827——Commissioners could borrow 30,000*l.*, and doubtless the North-Western Railway Company, communicating with West Riding of Yorkshire, would be anxious for the improvements of the port, 829–30——Annual average income derived from tolls about 1,200*l.* a-year, 831.

DENHAM, HENRY MANGLES, Commander in the Royal Navy, and F.R.S. . . . . p. 40
Has been engaged 30 years in the surveying service, 864——Enumerates the coasts and ports he has surveyed either in command or as assistant, among others the river Lune and Morecambe Bay, in Lancashire, 865——Opinion as to the difficulty of maintaining a deep-water entrance to the Lune; discovered deep-water channel from Lune Deep to Poulton Ring, in Morecambe Bay, 868——Proposes to make docks at that place, distant only 2¾ miles from Lancaster; the ground is level, and easily connected by railroad, 872——Far preferable to any attempt at improving the navigation of the Lune, 874——River may be deepened to 16 feet from Glasson dock to the new bridge, 876——Expense of cutting canal (including breast-work and basins) from Poulton to Lancaster, 130,000*l.*, 878——This would give 12 feet of water at pier-heads without deepening; Harbour at Poulton would avoid the delays of navigating the river; has known ships of 17 feet detained six days bound to Glasson, 882——Compared his survey of 1844 with one projected in 1826, is of opinion that the latter could not have represented the features of the Banks, from the great dissimilarity of the two, 884——From common report, since 1826, the sands have not advanced, 885——Tide flows up the Kent within half mile of Leven's Bridge, 12 miles above Poulton; navigable only for flats up to Milnthorpe, 888——The enclosing of the bay would create a large tract of land, and facilitate railroad communication between Lancashire and Cumberland, 889——If such a project were carried out, a harbour at Poulton could not be maintained, unless by the Kent and Keer rivers being brought down on the south side of the bay, 890——Is of opinion that present depth at Poulton Ring depends on the flux and reflux of tidal water, 892——Depth of water at high-water springs, over the top of the sand called Cartmell Wharf, 9 feet, across on the western edge 13, three miles farther 9, then 13 feet below low-water level in the channel; 3 miles farther, 17 at high water, 893——Full 57,000 acres of tidal water would be excluded if project were carried out, 894——Every enclosure of sand would lessen the depth of the bay, 895——Is of opinion that any enclosure would be prejudicial to the outer channel; but inside would embank all bights and sinuosities, and straighten the river course, 896——From time immemorial, there has been deep water off Poulton Ring, ensuring a permanent harbour, 898——If 10,000*l.* were to be expended on the improvement of the Lune, would do so on lights and buoys, and perching the channels and shallows, 901——Is not of opinion that 7000*l.* is sufficient to deepen the river to 16 feet up to Lancaster, 902——Advises a floating light to be placed on the south-west spit of the Fisher Bank Patches, and tidal lights on Sunderland and Chapel Points, or Abbey Scare, by which means vessels could anchor in Sunderland Hole, or proceed over the 4 miles of flats or bars to Glasson by night, 906——Arrangements for lights are local, the Quay Commissioners possess the light of Walney, erected in 1789, paying general toll; it is imperfect in its action; and they have 3 or 4 buoys placed in an irregular way, under the superintendence of a buoy-master, 907–912——Considers that local trustees should have no control over the navigation beyond the high-water mouth of the river, 911——Walney light ought to be a channel light; it lights vessels from Liverpool to the Solway, and all vessels entering the bay pay toll, 914——It is a very important light; it consists of a tower 80 feet high, with 3 argand lamps and reflectors revolving, obscured every 5 minutes, showing bright but *one* minute, 918——Navigation of River Lune deteriorated within the last 20 years, 919——Is of opinion that dredging would have little effect, 921——System of harrowing better and cheaper, such as was used in Victoria Channel, Liverpool; but is of opinion it could not be used successfully in the Lune, 923——The extension of the sand is the cause of injury to the navigation, 928——Rise of tide at foot of Lune 28 feet; at Glasson Dock, at high spring tides, 24 feet, 21 at ordinary spring tides; at Lancaster Bridge, 11 feet, 931——Depth of water between the present bridge and intended viaduct, 15½ feet at high water ordinary springs, at low water 6½, 933——No possibility of any vessel proceeding above the first buoy at foot of Lune, 11 miles below Lancaster Quay, and 5 below Glasson Dock, without the aid of a pilot, owing to the want of a light, and a proper system of buoyage, 933——Is of opinion that if the whole of such estuaries were placed under proper independent authority on the part of Government, that the navigation might long ago have been benefited, 936——Has observed the same neglect in navigation under other local authorities, particularly seaward of the mouth of the river, and considers that some competent authority, not local bodies, should direct the placing of buoys and other necessary improvements, 938——Harbours would then eventually be much improved, and the dues on shipping not misapplied, 939——Persons at present employed are not supported by the local authorities, and the latter do not possess sufficient knowledge on the subject, 942——Undertook to scour the Victoria Channel, Liverpool, but immediately after resigned a lucrative appointment, owing to the vexatious difficulties that arose, 944——Considers that in the Lune, where the tide rises 18 feet, dykes or walls would be necessary to direct the current, 945——The upper surface of dykes should come 3 feet above high water level, 946, 947——In case the dykes on the Clyde were pulled down to make way for half-tide dykes, it would confine the stream to steam navigation, as it would not be safe for sailing vessels, 948——Is of opinion that banks in the estuary of the Clyde, require all the tidal water, but that within the river dykes should be raised above high-water level, 949——The last half of the tide-scour is necessary to keep the channel deep, also as great a flow of the tide upwards as can be got for the sake of the outer banks, 951——Considers that the descending tidal water would not have the effect of keeping the channel clear within the river, 952——For improving the port of Lancaster, recommends abandoning the Lune to its present course *in toto*, and by establishing a harbour at Poulton, to enable a ship to approach within 3 miles of Lancaster at low water, 955——Should an embankment be run across Morecambe Bay, would recommend that the sea reach of the Lune over Sunderland and Cockram Sands be assisted by more buoys, and the interior of the

estuary straightened to define the outfall of the river, 956——Various plans for embanking Morecambe Bay have been suggested, 957——Considers the line from Poulton to Point Comfort feasible and advantageous, in stopping present dangerous indraught into the Bay, 959 ——Does not consider such an embankment would be mischievous, 960——Depth of water at embankment would vary between 41 and 9 feet, 961——States his opinion as to the phenomenon of the Lune Deep, where the depth jumps from 3 to 154 feet; thinks that the mouth of Morecambe Bay, now 8 miles across, was originally only 1½ miles. Lune Deep was then the outlet of all the rivers, but that it is now filling up, as the bay widens, as may be judged by the submarine spits which all point at it, 963-4——An embankment of pile-framing and rubble-stone might be built from Poulton, across the bay, sufficient to resist the action of the sea, and to carry a railway, 966——Is of opinion that the embankment would not destroy the entrances of the harbours of Lune, Wyre, and Piel, 967.

Surveyed the estuary of the Duddon water, on the coast of Lancashire, 1451——A solid embankment across it, would stop vessels that now go to Broughton quarries; but is of opinion that it would be more beneficial than otherwise, as the estuary presents no refuge capacity, 1453 ——At the proposed line, 3 miles below the Burlington slate quarry, there is 20 feet depth in the channel at high-water ordinary spring tides; vessels drawing 6 feet reach 4½ miles higher; open punts go up to Duddon Bridge, and the tide flows ¼ of a mile above, 1458—— Rate of tide at proposed place of embankment, 3 knots on the flood and 3½ on the ebb, which would be stopped by the embankment, 1460——Considers that it would cause slight privation of water-carriage to the surrounding country; a railroad is in progress of formation from Kirby Pool to Piel Harbour, 1463——This estuary is the outlet for the waters of the Duddon and Kirby Pool, but is not aware of any traffic upon them, 1465——Duddon estuary drains the lakes, Kirby Pool, Simpson's Beck, and Salthouse Pool, 1469—— And the embankment would entirely destroy its navigation, 1472——Would exclude about 1300 millions cubic feet of water on every tide, 1473——In order to dispose of the waters above the proposed embankment, either sluice gates or a new channel must be made, 1474—— The seaward side would no longer be navigable, 1476——Considers that the railway might be carried out by a circuit of eight miles, and so avoid the embankment, and all interference with navigation, 1479-81——Recommends the crossing to be by an embankment with arches, 1483 ——Depth of sand is nine feet, then clay; piles and rubble-stone wall form the embankment, 1490——Contemplates shutting out entirely the flow of the tide, both here and in Morecambe Bay, 1495——Considers that owing to the long flat of two miles, extending off shore, it is impossible, either by dredging, buoys, or beacons, to maintain a channel so as to make the Duddon even a limited refuge harbour, 1503——Embankment at Salthouse Pool was made in 1830, to redeem 260 acres of marsh, over which the sea ranged two feet at high water springs, thereby excluding 7½ millions of cubic feet of water, 1506——There are several other embankments, 1508——A railway might be carried along shore to the southward of Millom Hill, 1509—— Numerous objections to constructing a railway from Poulton to Cowper Point, to Chapel Island, and thence to the mainland on the north-eastern side of Morecambe Bay, 1510——It would shut up ten rivers or streams, 1511——With the exception of the proposed pier at Poulton Ring, considers an embankment across Morecambe Bay of public advantage, 1512——Is of opinion that the shutting out of so large a body of water would silt up the different channels in the bay; yet would not be injurious to the early tide ports, the Lune, Wyre, and Piel, but destroy all above, with the proposed port at Poulton Ring, 1515——Observed several encroachments on the banks of the Duddon and Morecambe Bay, 1518——All ebbing waters do not scour a bar, some deposit on it, and increase it, 1523—All water assists in keeping open a channel, but as that is kept open the bar works out seaward, rendering the entrance like that of Liverpool, 1525 ——Where a bar has extended to the limit of the velocity of the ebb tide, it will go on accumulating, and is hopeless; if it lie within the range of a rapid ebb stream, artificial means may be useful, 1526——Extent of bar depends not so much on depth of water as on reaching the fair channel stream, the Wyre for instance; the Duddon sands will project till they reach the fair set of tide in the Irish Channel, 1527——An estuary that presents the form of a prostrate cone, with its base outwards, is hopeless, 1528——All estuaries do not present the same features; distinction drawn between the Dee and the Mersey, 1529——If the Burbo and East Hoyle Bank between the Mersey and Dee did not exist, the channels of the river would not be kept open, 1532——To improve the Lune sea reach it would be necessary to embank Sunderland Point both in its river and sea face, 1534——An embankment across Morecambe Bay would have a beneficial effect on the sands at mouth of Lune, by diminishing the scour of the bay, and consequent deposit of sand, 1538——If Cartmell Wharf were walled up, the same effect would be produced on the channels of the Kent and Leven as on the Lune, 1541——Lune Deep was the original outfall of all the waters of the Lune and Morecambe Bay, 1543——Conjectures why it has not been filled up by the sands, 1544——In case Morecambe Bay be cut off by an embankment, the sands would immediately break in, and the Lune Deep very slowly fill up, 1545.

MACDONALD, JOHN, Secretary to the Trustees of the Arbroath since 1839 . . . . . p. 45

Since the Act of 1839, the sum of 58,000*l.* has been expended in purchasing and improving the harbour, 975——Act gave power to borrow 50,000*l.*, and the trust is now 3000*l.* in debt, 976 ——Depth at high water 12 feet; at low water the harbour is dry, 978——Proposes to deepen from 3 to 6 feet, extending 233 yards from pier-heads, 980——Boulders and soft freestone rock to remove, at an estimate of 9000*l.*, so as to admit a vessel drawing 16 feet at high water, 988 ——No funds to do it; interest of debt 2350*l.* a-year; 800*l.* a-year expenses of management; revenue 3050*l.*, 993——Unless the entrance be deepened, revenue will fall off, 995——If deepened, all coasting vessels would be able to take the harbour, 1001——Of the money borrowed, 25,000*l.* are on the personal guarantee of individuals connected with the port, 1004—— Area of the harbour 6 acres, works stable, and foundation deep, 1010——Estimate is only for deepening. 25,000*l.* additional would be required to finish the inner docks, and north pier, 1012——*Capt. Washington*, R.N.—If deepened as proposed, it would be a tidal harbour of refuge for 12 hours out of the 24, for all vessels not exceeding 10 feet draft of water, 1021—— Very great need of a harbour on this part of the coast of Scotland; in the year 1800, not less than 13 vessels were wrecked in one night, within 6 miles of Arbroath, 1027——Depth of water at

one cable's length from low-water mark is 18 feet, and 6 fathoms at a quarter of a mile beyond, 1029——Knuckle Rock and Cheek Bush should have beacons on them, 1030——Does not wish a passing toll granted for its support, 1032——Is of opinion that Arbroath, from the public spirit of the Trustees in spending 58,000*l.* on its internal improvements, has greater claim to a small grant from Government than any other port he is acquainted with, 1033——Mr. *Macdonald.*—Deepening the port would increase the traffic, and thus the dues would pay off the debt, 1036——Unless it is done, the works will deteriorate, 1039——Government gave no aid towards making it, 1040——All the services of the trustees are gratuitous; they are 19 in number, and publicly elected: the accounts are audited and published annually, 1053——Population of Arbroath, 15,000; chief trade flax-spinning and manufactures, 1058——In 1840, 777 vessels of 48,193 tons, entered the harbour, 1069——Harbour dues vary from 1½*d.* to 1*s.* 6*d.* per ton. If the money sought were advanced, it would be scrupulously applied to improvements of the entrance, 1082.

STEAD, PATRICK, a Merchant and Maltster at Halesworth, on the River Blyth, in Suffolk . p. 50
Has traded to Southwold since 1817; exports annually about 20,000 quarters of malt and corn, and imports 3000 tons of coals, 1088——Considers that the merchant pays the port dues, 1089——Has made serious complaints for many years against the state of the harbour of Southwold; the bar is very bad, 1091——Has reason to believe the harbour was formerly in a better state, 1094——*Lieut. Ellis.*—Admits that such is the effect of the evidence referred to, but does not concur in it. A lighter was built formerly, to lighten vessels outside the bar, but was sold in 1815 for a dredger, 1100——Larger vessels probably entered the port formerly before the river was curtailed by encroachments of the sea, 1101——Mr. *Stead.*—Has made repeated representations since 1827, as to the neglected state of the port, 1114——Recommends dredging and cutting through the Bellar Shoal; estimates loss on corn shipped at Southwold at 1452*l.* a-year. Got no redress, 1114–15——In 1830 a new Bill was obtained; tried in vain to get the interests of the town represented in it; 32 Commissioners appointed; landowners, clergymen, to be self-elected, and 2 bailiffs of Southwold, 1126——A public meeting at Southwold, in order to get a clause of a more open character, but in vain, 1127——Harbour since that time has been at times very bad; in 1838 or 1839 the bar was for several days dry at high-water, and no vessel could get in or out, 1143——Attributes it in great part to the embankment of the marshes by the adjoining landed proprietors, 1145——From Mr. Walker's Report 1504 acres of marsh land have been embanked, thereby excluding 148 million cubic feet of water on every spring tide; there were also 1200 acres, at a similar level, embanked, which he did not survey, 1148——Knows of no authority for such embanking, 1150——The chief part of the embankments took place prior to 1806, 1157——Cites Rennie's opinion for the injury to the harbour caused by them, 1168——Case of Wells submitted to serjeant Grose, who pronounces all such embankments nuisances, 1177——Decided in 1781 against embankments, 1178——Cites Chitty's opinion on Southwold, who declares the embankments to be nuisances, 1183——Applied to the Admiralty, Woods and Forests, and House of Commons, 1184——Wolsey Creek is the lower limit of the Blyth Commission, 1193——Governing Act of Blyth Commissioners, 30 Geo. II. cap. 47, 1198——Next to the removal of the embankments, the river should be dredged and Blybro' Bridge, which Mr. Walker terms "a disgrace to the county," should be removed, 1200——Wangford Bridge, of far inferior importance, has been rebuilt, 1201——There is a large extent of embanked land to the westward of Wolsey Bridge, not mapped by Mr. Walker, in addition to the 2704 acres of enclosed land which he states in his Report. Estimating the value of the land at 30*s.* an acre, the back rent due would be upwards of 300,000*l.* Witness has asked the Southwold Commissioners to use a rake to deepen the river; to employ a small steam tug to tow vessels in and out of the harbour; and to build piers of concrete, faced with rubble stone, instead of wooden piers, which the worm destroys. Comparing the Report of Edwards in 1757 with that of Walker in 1840, the flow of the tide at Blybro' Bridge was the same then as it is now; it cannot therefore be said that the embankments have increased the flow of the tide. Is of opinion that the expenses of management are very high, and that the dredging cost twice as much as it need have done, 1203——In the Tay, near Perth, the dredging cost 2¼*d.* per ton for gravel and 3½*d.* per ton for clay. The detention of vessels for want of water over the bar has been excessive; in consequence has been compelled to give up the shipment of corn, as also has another large corn merchant, 1210——Is distinctly of opinion that the lands now enclosed and formerly overflowed by the tide are Crown lands, 1213——Chairman of Southwold Trust produced Mr. Rendel's abstract opinions at the annual meeting, as an argument that the embankments had done good instead of harm; and Mr. Rendel now states that his opinion is by no means applicable to Southwold Harbour. A promise was made to the witness that four Commissioners might be elected from the shipowners, &c. of Halesworth, but this was not done, 1216——When the Harbour Bill was in Committee three of the members of the Committee elected themselves into the Commission. Several petions against it. Considers himself very hardly dealt with, as he pays one-third of all the port dues. The qualification of a Commissioner is too high; is of opinion that all their proceedings are illegal, 1218——Has complained of the embankments to both houses of Parliament, to every department of Government, and taken every constitutional means to obtain redress, but in vain, 1224——Has repeatedly applied, but has never been able to see the proper account books, such as the Act requires, 1225——Gives in account for 1843, and remarks on a charge of 500*l.* for labour, 1240——Refused sight of surveyor's and minute book, 1241——Dredging at Perth costs 2¼*d.* and at Southwold nearly 1*s.* Owing to the bad state of the harbour the freight on corn and malt is about 1*s.* 6*d.* a ton more than from Yarmouth. At Southwold harbour dues on coal 1*s.* 2*d.* a ton, at Yarmouth only 6*d.*, 1257——The marsh embanked to the westward of Wolsey Bridge is about 300 acres in extent, and below the level of high water springs, 1263——Out of all the embanked lands and encroachments on the river, the only thing he has ever known ordered to be removed was an encroachment made by witness in marking the boundary of his malt-houses, which order was signed by the Chairman, 1265–6——Was present at the inquiry into Southwold Harbour made in 1844 by order of the Admiralty, and is satisfied that it was quite public, and that every one was invited to bring forward any evidence which could throw light upon the subject, 1267.

BLANDEN, WILLIAM, Wherryman, of Halesworth, in Suffolk . . . . . p. 61
Is 76 years old, and has traded 64 years on the river Blyth, 1277——Is of opinion that the embankments have caused damage to the harbour 1278——Remembers the embanking of Bulchamp and Blythbro' Saltings, 500 acres in extent, formerly covered by water, and which he has often crossed in his boat, 1278–83——Current now much less rapid than formerly, 1284——Remembers vessels drawing 9½ feet coming in at half flood, and now barely at high-water, 1288——Blythbro' Bridge is a great impediment to navigation, boats cannot get under it at high-water, 1300——There is not the flow of water in the river now that there used to be, 1301——The lower part of the harbour has been improved by dredging, &c., since 1830; there was less detention in passing up and down the river formerly than now, 1311.

ELLIS FRANCIS WILSON, Lieut. R.N., Harbour Surveyor of Southwold since 1829 . . . p. 62
Shows by extracts from history the former bad state of the harbour from 1328 down to 1747; then quotes the Minute Book, which speaks of the harbour being cleansed out, but says nothing of its being blocked up, 1313——From Maggs' Hand-book it appears that between 1805 and 1818 it was dug out 13 times, 1314——Minute Book contains no entry respecting the embankments being made, nor any complaints against them prior to 1830; great improvements in the lower part of the harbour since that period; from 1830 to 1839 harbour was not once blocked up, 1325——Knows nothing of any embankments having been made except from the Reports of Rennie and Walker, 1330——Is of opinion that the embankments have not been an impediment to the flow of the tide, 1332——Is of opinion that if the embankments were removed a a larger body of water would not come into the harbour, 1334——States that in 1840 Mr. Walker, in his Report, makes the rise of tide at Blythbro' Bridge 6½ feet, and as Edwards in 1757, and Rennie in 1830, make it only 5 feet, consequently 1½ feet of rise have been gained, 1334——River has lately been dredged, which has admitted more water, 1337——Is unquestionably of opinion that by admitting in every possible way the influx of the tide the river would be improved, 1344——In E.N.E. gales the harbour blocks up by shingle, 1346——Considers that the accounts of the harbour are kept in a regular manner; lays on the table printed abstract of accounts from 1836 to the present time, 1350——Mr. Stead has never applied to him for an inspection of the surveyor's or collector's book, 1352——Declined to show him the Minute Book, which he had no claim to see, 1353——The harbour work is publicly contracted for, 1355——From 1833 to 1836 the dredging was done by their own steam dredges, but the wherries and labour were contracted for at 4¼*d.* per ton; in 1839 the Lowestoft dredge was hired, and the contract for wherries and labour was 5¼*d.* per ton; the contract alluded to in the Tay, by Mr. Stead, at 2¼*d.* per ton, was for labour only. The town of Halesworth is more fully represented in the Harbour Commission than Southwold, 1361——Is of opinion that the Southwold Commissioners have no power over the embankments on the Blyth; Blythbro' Bridge, also, is out of their jurisdiction. Salary of Harbour Master and Collector only 100*l.*, at Yarmouth it is 500*l.* a-year, 1361——Admits the accuracy of Mr. Walker's Report of 1841 as to facts, but thinks his calculation fallacious, and does not believe that 150 million cubic feet of water at every spring tide have been excluded from the harbour, 1364——Is of opinion that the embanked lands, had they remained open, would have silted up ere now, 1365——Admits that Rennie says, in his Report of 1830, that spring tides rise at Southwold 6½ feet, and at Blythbro' Bridge nearly as much, but asserts that he says before that the rise is only 5 feet, and Edwards, in 1757, says the same, 1368——The volume of fresh water brought down by the river Blyth, except in wet seasons, is insignificant, 1370——In order to improve Southwold Harbour it would be desirable to widen and deepen the channel of the rivers, and to clear out the creeks, by which a great additional quantity of water would be brought in and out of the harbour, giving a greater momentum to the current, and thereby very much improve the bar. If the above means were adopted would expect great increase of water over the bar, which is now only 10 feet at high-water, 1380——Spring tides run out at 4 knots an hour, 1381——Approves generally of Mr. Calver's plan for improvement of the entrance of the harbour; it is the best hitherto proposed, 1383——Is of opinion that extension of the piers would be prejudicial; the *teredo navalis*, or some similar destructive worm, abounds at Southwold, and does much damage to piles, &c., 1384——The Harbour and River Commissioners should be merged into one; would suggest the formation of a Central Harbour Board, with local inspectors, to have control over all harbours in the United Kingdom; to have one general Harbour Act, assimilating the constitution of the local Boards, provisions, penalties, dues, &c., to regulate pilotage; and to have annual returns of receipt and expenditure, and all other things relating to each harbour, 1379.

STEPHENSON, GEORGE, Engineer to the Whitehaven and Furness Junction Railroad . . . p. 68
Proposed line goes along the coast from Whitehaven to St. Bees, Ravenglass, and across the Duddon Sands to Furness; the object is to carry the iron-stone, 1386——No part of the plan, at present, is to cross Morecambe Bay, but it may be next year, 1387——Proposes to cross Duddon Sands by an arched embankment 1¼ mile long, 1395——Would probably cut off 5000 acres of the Duddon Sands, at 4 miles below Broughton, 1396——Means to make an outlet for the river Duddon, but this is not in the Bill; mode of proceeding would be by piles; then to lay a wooden railway at top 6 feet above high-water mark, and drag waggons to and fro loaded with stones to be dropped between the piles, and thus gradually raise all parts above high-water, 1400–1——The bed of the river above the embankment will become land, claimed by the Crown and the neighbouring proprietors, 1405——If this line were obtained it would be a reason for asking for a line, next year, to cross Morecambe Bay, 1411——Complaints against the embankment have come from Broughton, and it is intended to give that place a railroad instead of the present navigation, 1412——Would not propose a swing bridge; the current of water would be so strong, that no engineer would undertake it, 1413——To cross from Shaw Point to Angerton would carry the line a long way round. The present proposal is the only line witness would undertake, 1416.

LORD ADVOCATE OF SCOTLAND . . . . . p. 70
Explains the state of the suit pending between the Montrose Harbour Trustees and Sir James Carnegie relative to the embanking of certain lands upon the banks of the South Esk near Old Montrose.

LONSDALE, The EARL OF, Chairman of the Whitehaven and Furness Railway . . . . . p. 77
Is proprietor of about 1000 acres of land on the side of the Duddon Estuary, 1546——The 250 acres of land embanked was under the Millom Enclosure Act of 1820, and which empowers to enclose about 1000 acres, out to mid-stream, 1551——Thinks that the opinion of the Admiralty was not asked as to whether such an inclosure would interfere with the navigation, 1554——The land was chiefly dry at low-water, but always covered at flood, 1556.

LESLIE, JAMES, C. E., of Dundee, Engineer to Montrose Harbour . . . . . p. 78
Was consulted by Sir J. Carnegie, in 1841, about the best mode of protecting his land from being encroached upon by the river South Esk, and recommended that he should divert the channel of the river a little, which he did; witness recommended to Sir J. Carnegie not to attempt to enclose land, but in the following year he ran an embankment across and shut out the water, 1566——The first operation would not have made any alteration in the flow of the tide, 1569——By the latter 66 acres, over which the water flowed 4 feet at spring tides, has been enclosed, and 12 million cubic feet of water excluded on every spring tide, 1581——A prior embankment of 50 acres, made in 1831, has excluded 9 million of cubic feet of water on every tide, 1587——Is decidedly of opinion that shutting out the tidal water is injurious, 1589——Is acquainted with the encroachments on the Tay near Powgavie, about 6 miles above Dundee, where a dyke upwards of 1000 yards long has been run out from the north shore into the river; the effect of this and other walls would be to silt up an area of 2000 acres in extent, or about one-ninth of the whole area of the Tay between Dundee and the mouth of the Earn, 1600——Proposed two years since to cut away a projecting point of rock at Magdalen Yard in order to set the current past the sea face of the docks at Dundee, 1606——Tried formerly to dredge away the Ballast Bank, 1613——As a general principle would recommend an estuary to be preserved entire, 1624——Is of opinion that the point of the Middle Bank has not come lower down since 1832. It would be a great advantage to Dundee Harbour to have the Fowler, Beacon, and other rocks removed, 1638——Is not aware of any great fresh in the Tay within the last 10 years; does not attribute the deepening at Tay Bar to any improvements in the upper part of the river, 1640——Recapitulates the chief harbours that he has examined and reported upon, 1648 *a*——The chief obstructions to the propagation of the tide in rivers are straits, sinuosities, fords, and shoals, 1648 *c*——These may be removed by blasting, dredging, straightening the channel, &c., according to circumstances. The depth of a river in its lower part is almost entirely due to the tidal waters, in its upper part to freshes, 1648 *f*——At Dundee the cost of dredging mud and sand, and depositing it above high-water mark is from 7*d*. to 7½*d*. per cubic yard, when dropped from hopper punts about 6*d*., 1648 *i*——Is of opinion that a Harbour Board in connexion with the Admiralty to look after encroachments and the general interests of harbours, and to decide whether any projected work was desirable or not would be highly beneficial, 1648 *j*.

BURNES, ADAM, Solicitor, and Clerk to the Montrose Harbour Trust . . . . . p. 82
States the present position of the suit pending between the Montrose Trustees and Sir J. Carnegie, respecting encroachments on the banks of the South Esk, near Old Montrose, 1652——In June, 1842, remonstrated by letter, and in person intimated an interdict against them, 1656——Also memorialized the Admiralty, and Mr. Rendel, C.E., was ordered to inspect and report upon the works, 1657——Having recently completed a wet dock and other works at Montrose, at a cost of 42,000*l*., the trustees have expended all their funds, which alone has prevented their instituting legal proceedings; they, therefore, applied to the Admiralty to help them, 1663——The trustees have been always anxious to guard against any encroachment upon the tidal waters of the basin, 1668——Three other encroachments have been made by the predecessors of Sir J. Carnegie, one in 1817, another in 1830, and a third in 1831, of about 60 acres each, 1681——The revenue of the harbour is 3,400*l*. It would be a great improvement to remove a rock called the Stone, at the entrance; or at least to put a beacon on it. Is of opinion that this is the duty of the Commissioners of Northern Lights, 1677.

STEVENSON, DAVID, of Edinburgh, Civil Engineer . . . . . p. 84
Has surveyed and reported upon the Dee, Ribble, Lune, Wyre, Tay, Forth, &c.; one general principle in the improvement of rivers is, that as the fresh water cannot be materially increased by any work of art, every effort should be made to increase the duration of the tidal influence, by removing obstructions, as fords, jetties, weirs, and the slope of the river's bed, 1685–6——In all our rivers at low water the slope of the surface is from the sea *upwards*, but at other times it is from the sea *downwards*, and it is very desirable to reduce this nearer to an equality; in the Dee at low water there is a fall of 11 feet from Chester to Flint, a distance of 12 miles, but on one occasion it was found that there was a fall of 8 feet nearly from Flint *upwards*; also, on the Lune, between Lancaster and Glasson, 6 miles distance, there is a slope in the bed of 11 feet, and on one occasion the surface of the water had a slope from the sea of 4 feet 4 inches *upwards*, 1687——Impediments may be removed by excavation, by guiding the course of the stream, or by dredging. From 5*d*. to 6*d*. per cubic yard is a fair price for dredging gravel, including all expenses, 1690——Depths of rivers chiefly due to tidal waters. Detritus brought down by the rivers more to be feared than deposit from the sea, 1692——Tay and Ribble are instances of the beneficial effects of works designed in conformity with the above principles.

In the Tay, boulder stones of 50 tons weight have been removed, a depth of 3¾ feet has been gained over the fords. Embankments are sometimes useful, but in general it is desirable to give compensation for them by deepening the channel, 1697——The improvement in the tidal phenomena has been in proportion; has gained 50 minutes in time, and 1¾ mile per hour in speed, on the first wave of the flood tide, 1700——A million cubic yards of water, in addition, passes Newburgh on every tide, 1705——Conceives the Tay capable of further improvement, even to 18 or 20 feet depth at high water spring tides at Perth, at a cost of 50,000*l*. The average slope of the bed of the river is still 5 inches a mile from Perth to Balmbreich, and 10 inches a mile from Newburgh downwards, 1713——Jetties also should be removed, which may be done by a late decision of the Court of Sessions, 1715——Depth of water from Flisk downwards is at no place less than 30 feet at high water springs, 1724——Has found great difficulty in persuading the landowners to remove jetties, &c., 1726——Is of opinion that the Middle bank is of sand, 1736——Is acquainted with the embankment begun on the north shore of the

Tay, to extend from Cairnie Pier downwards. The proprietor of the adjoining land was permitted by the Perth Harbour Trustees to deposit materials on a line approved of by the engineers to the river, for the purpose of directing the current favourably, and for improving certain fishing stations; but witness is not prepared to say what may be the effect of completing that embankment, as proposed in the proprietor's application to this Commission, 1770.

On the Ribble spring tides formerly rose only 6 feet at Preston, and flats carried the cargoes of vessels up from Lytham, 1740——About 30,000 cubic yards of rock have been excavated near Preston; 800,000 tons of gravel have been dredged, and 7½ miles of low rubble wall have been erected in the lower part of the river. Range of tide at Preston has been increased 4 feet; in the beginning of 1840 no vessels but flats came up, and now 95 vessels in a quarter of a year have come up to the quays, and the dues have been nearly quadrupled, 1741——Ribble is susceptible of further improvement; from 18 to 20 feet might be obtained at Preston. Tide flows 4½ miles above the town, or 21½ miles from the Irish Sea, 1746——Cost of the late works 47,000*l.* nearly, 1749——Similar improvements might be made in the Lune, Forth, Trent, and Dee, 1755——The Dee is an instance of injury from artificial obstructions placed in order to gain land, about 4,000 acres have been enclosed by an embankment 7 miles in length, the line of which has been most injudiciously laid out as regards navigation. A weir has been erected at Chester, rising 11½ feet above the bed of the river, which dams the water up for 6 or 7 miles, and checks the flow of the tide above the town. On the Lune, also, land has been enclosed, and weirs also exist which check the flow of the tide. On the Wyre there are obstructions. On the Ribble the jetties formerly were very prejudicial, 1759——Has surveyed the Forth from Stirling to Alloa, 1771——There are seven fords, consisting chiefly of whin boulders; these should be removed, so as to gain 3 feet water up to Stirling; the depth is now 10 feet, it should be at least 13 feet at high water spring tides, and then vessels might reach Stirling in one tide. The cost of such works would be 9,400*l.* nearly, 1773——Alloa and Tillibody Islands are surrounded by embankments, and there are several others which exclude the tidal water, 1778——Tide flows to the Cruive of Craig Forth, 4½ miles above Stirling, where it is impeded by a mill dam, against which it rises 4 feet, 1787——The distance by the river from Stirling to Alloa is 10½ miles, by land, 7½, 1795——The slope of the bed of the river between these two places is 11½ feet. Ordinary spring tides rise at Leith, 16½ feet; at Alloa, 19 feet; at Stirling, 8 feet, 1799——Is aware of embankments near Kincardine, but not of their extent, 1804.

Is of opinion that it would be beneficial to establish a central Harbour Board, in connexion with the Admiralty, to have the superintendence of all the ports and navigable rivers of the United Kingdom. Considers the rivers as so many public highways, which should be guarded for the public against the interests of the landowners, which are in most instances hostile to the interests of navigation, 1760——Is of opinion that every local Harbour Board should have a portion of its Commissioners appointed by the Admiralty, so as to be uninfluenced by property or local bias, 1763——There is no doubt that such a Board established a century ago would have prevented many injuries that have been produced by encroachments, 1764.

GALBRAITH, WILLIAM, Town Clerk of Stirling . . . . . p. 90

A memorial has been presented by the Commissioners of the Forth Navigation, complaining that the navigation of the river between Alloa and Stirling is much obstructed by fords and shallows, 1806——An application has been made to the Treasury, asking to advance money on the security of the rates, 1807——Revenue of port, 350*l.* levied by dues on tonnage, 1813——Act of 1843 authorizes to raise 10,000*l.*, but only half of its till 5,000*l.* has been expended on the improvement of the river, 1824——Have only raised 1,600*l.*, the greater part expended in obtaining the Act, 1825——Vessels of 150 tons have reached Stirling at high water spring tides; wool, grain, and limestone form the chief trade, 1829——The only guarantee that can be offered as payment of the interest of any loan are the rates authorized by the Act to be levied; those at present amount to 350*l.* a-year, on 5,000*l.* being expended these might in part be doubled, and thus produce 600*l.* a-year; on 4,000*l.* more being expended, the full rates might be levied, or 850*l.* a-year; and thus, although there were no addition to the present traffic, ample funds would be available to pay 3 per cent. interest on 10,000*l.*, and to form a sinking fund of 400*l.* a-year for the redemption of the debt, *App.* p. 163. Would gladly concur in any arrangement on the part of the Admiralty for improving the river, 1843—The shipping belonging to Alloa amount to 99 vessels, of 17,392 tons; to Stirling, 24 vessels, of 1,048 tons; and 3 steamers. Arrivals and sailings at Alloa, 806; at Stirling, 526 yearly, besides 492 steam trips, 1848——Has tried in vain to borrow money from any public body or Scottish bank, 1849——Craig Forth Weir was by a grant of one of the Kings of Scotland to the then Lord Elphinstone, for his salmon fishing. The town of Stirling objected to it, but it was overcome. Has furnished a copy of the grant to the Commission, 1860.

RENDEL, JAMES MEADOWS, Vice President Inst. of Civil Engineers . . . . . p. 92

Certain abstract questions relative to rivers were put to him some time ago by Lord Stradbroke, 1866——The questions arose from evidence given by witness shortly before, respecting the river Mersey, in which it was shown that the water did not rise to the height in the higher part of the estuary, that it did at Runcorn, owing to its escaping into the creeks near the mouth of the estuary, and thus the momentum of the tidal stream was impaired, and any work that had the effect of correcting that loss of momemtum would have the effect of carrying a larger body of water into its upper portions, 1867——The answers to the questions were certainly not given in reference to Southwold Harbour, 1872——Was not aware that the answers had been considered applicable to Southwold for reasons stated, 1873——Has not been able to lay down any general principle for the improvement of rivers, but must treat each case according to its peculiarities, 1875——In the case of Southwold the bar is the first point to be treated, and its state depends on the quantity of water passing to and fro over it; anything therefore that diminishes the quantity of water in the estuary would unquestionably have a tendency to increase the bar. There are many harbours, Berwick for instance, where the stream is so great at the piers, that it amounts to a greater objection than the bar itself, and consequently there it is very desirable to lessen the stream, 1878——Inequalities in the bed and shores of a river are the chief obstructions to the propagation of the tide. Tide is often higher at entrance than in the upper parts, owing to the contracted mouth it has not time to fill the basin within.

Great advantage of having a harbour in such a form as to have a higher tidal flow at its inner end than at its entrance. In the Mersey, the tide rises at Runcorn, 20 miles from its mouth, 18 inches higher than at Liverpool, but from Runcorn to head of estuary it falls. To remove the stricture at Runcorn would be an advantage. Has a great objection to a stronger stream than is necessary to remove the bar, for it creates so much disturbance, that it is the cause of evils as great as the bar itself, 1881——Is of opinion that the Slob or mud bank on either side of Belfast Lough might be advantageously embanked, for there is both ample fresh and tidal water, and no bar. In Lynn the harbour is always best in winter, owing to the extra scour caused by the increase of shipping, 1882——In all estuaries encumbered by sands at their entrance nothing that tended to lessen the quantity of water going into the harbour ought to be permitted; but embanking does necessarily imply a diminished quantity of water in a harbour, 1883——If the tide at upper end of a river does not rise as much as at entrance, it will be of advantage to cut off any creeks in its lower part, 1885——The whole engineering condition of a harbour should be minutely investigated before any engineering works ought to be permitted, 1890——It is the nice discrimination of all minute differences which constitutes the value of an opinion in cases of this kind, 1895——Harbours are frequently injured by the mouth being too narrow more than being too wide, 1896——Harbours require constantly watching, 1898——More harbours have been injured by injudicious improvements than by natural decay, 1899——Considers that local interests often interfere most destructively with the general interests of navigation, 1930——Is of opinion that every harbour should be placed under the superindence of Government control, provided that Government could command properly qualified persons, otherwise a greater evil would arise from ignorance than from local cupidity, 1901——Considers the Admiralty the proper Board to have conservancy of the harbours of the kingdom; no minor Board would possess sufficient influence; the present practice of referring particular cases to men of eminence in their profession is probably the safest course the Government can adopt, 1902——Is of opinion that it is most material to the preservation of the public harbours of the nation that there should be at once made accurate plans, comprising the full extent to which the tide flows. It is only recently that the Admiraty surveys have been worth anything, as far as the improvement of the harbours is concerned, 1907——Every change in a harbour should be recorded upon an accurate plan; nothing would help an engineer more than thus to know the history of a harbour he is called upon to improve, 1908——Is of opinion that no visiting engineer, no one but a resident engineer or harbour master could record such changes and minutiæ as ought to be noted in order to render the record useful, 1909——Would prefer the reports of local engineers to those modified by the views or opinions of a superintending engineer, 1910——The control of harbours should rest with the Admiralty, and considers their decisions have been judicious, and maintained with proper firmness. It ought to be an indictable offence to interfere with a harbour or the flow of the tide without the sanction of the Admiralty, 1914——Knows many cases where great injury has been inflicted by works authorized by Parliament, 1916——Knows many instances of damage from neglect; also encroachments made silently and likely to escape most observers. Has known instances where encroachments have begun with wicker-work, then stone dykes, then shut the tide out altogether, 1918——A public Harbour Act is wanting. The Admiralty should have a veto on the appointment of harbour trustees. Has often reported to the effect that a certain number in all harbour trusts should be appointed by Government, 1921.

Was employed by the Admiralty to report on an embankment made by Sir James Carnegie in the basin of Montrose. Recommended compensation to be made by deepening the channel. Observed many other embankments on the shores of the basin. Montrose is a case in point in which a good engineering and nautical plan of the port is absolutely necessary. Ten and a half millions of cubic feet of water have been excluded by the recent embankment at every spring tide, 1926–35.

CHAPMAN, HENRY CLEAVER, Merchant and Shipowner at Liverpool . . . . . p. 98

Has been 12 years at sea, trading to London, and 15 years resident at Liverpool, 1939——Was at Liverpool when Captain Denham called attention to the Victoria Channel, 1944——This channel is delineated in Greenvile Collins' "Coasting Pilot," of 1688, but had fallen into disuse for want of buoys, 1946——After much importunity Captain Denham got permission to buoy it, and afterwards it was lighted; it is now the best channel into Liverpool, and witness would as soon take a line-of-battle ship in by night as by day, 1951——Has never sailed a ship through the Victoria Channel, but has frequently been in and out in steam-boats and yachts, 1992——The works of the docks have silted up the Rock Channel. The appointment of a Conservator has given great satisfaction to the commercial interests of Liverpool, 1961——Between 1830 and 1839 the state of navigation as regarding lights, buoys, and management was very bad, 1968——Attributes the change to Captain Denham's exertions, 1970——Considers that it would be highly advantageous to have a general superintendence over all the harbours, 1971——So badly is it considered that the docks are managed at Liverpool that some merchants were on the point of memorializing to have them put under a Government commission, 1976——The lights, buoys, &c., are all under the Dock Committee, 1982——It is not of necessity that any of the Dock Trustees should be seamen, 1986——They consist of 13 deputed by the Common Council, and 8 elected by the dock rate-payers; the former depend upon the political opinions of the majority, 1988——When the trustees apply for a new Bill Government should embrace the opportunity of altering the constitution of the dock trust; the rate-payers should be convened annually, the trustees should give an account of their trust, and the shipowners and merchants should be allowed an opportunity of stating their complaints, 1993.

HICKS, CHARLES, DAVID MANSER, and HENRY STOCKS, Chairman, Clerk, and Harbour Master of the Rye Harbour Trust . . . . . p. 101

The western and eastern groynes at Rye have been run out according to the opinion of the majority of those who happened to be sitting as Commissioners, 2006——Mr. Cubitt was consulted as to improvements, but the Commissioners did not concur in his Report, and would not act upon it, 1998——There are 48 Commissioners who attend tolerably well, 2010——There are three sluices across the three rivers about a mile above the town, which entirely stop

the flow of the tide, 2024——If these were removed the tide would flow 10 miles up the Rother and 7 miles up the other rivers, 2025——The sluices were erected 50 years ago, and re-erected 10 years since, 2026——Scott's Float Sluice was broken down by the tide in 1813, and was down for two years; the effect upon the bed of the river was to deepen it, so that a boat could go up to the town at low water spring tides (*Stocks*), 2043——The indraught was so great that the flood stream continued to run up the river after the water had fallen two feet at the pier head, 2050——Dredging would be a great benefit to the channel, but cannot do it for want of funds, 2062——Average revenue about 1,300*l.*, last year only 1,050*l.*; amount of debt 1,500*l.*; expenses of management about 400*l.* a-year, leaving 600*l.* to be laid out in improvements, 2076——An area of 734 acres of marsh on the banks of the river, below the sluice, has been embanked since 1833, by consent of the Harbour Commissioners, 2087——In the event of a railroad crossing the river at a quarter of a mile above the town, it would prevent the passage of 112 sailing vessels annually that now go up to Scot's Float Sluice, 2125——Barges go 15 miles higher up the Rother to Bodiham Castle. At times great freshes in the Rother, 2106——Width of river at low water, at a quarter of a mile above the town, 102 feet; any bridge across would be an impediment to navigation. The eddy tides make the case more difficult; the tide rises 23 feet in the bay, and 14 feet at springs at the town, 2187——The Nook was embanked in 1839 without any authority, 2213——It excluded 10 million cubic feet of water on every spring. The Admiralty Commissioner did not report it to the Admiralty, because he thought the Nook without the jurisdiction of the harbour, 2224——Scot's Float Sluice was pulled down by the people, in 1830, as a nuisance, but was rebuilt by Act of Parliament, 2227——The Rye Harbour Commissioners were consenting parties to, and received 7,000*l.* for the 734 acres of marsh embanked in 1833. These lands were covered with 3 feet water at high tides, and thus 30 million of cubic feet of water were excluded, and its scour over the bar lost at every spring tide. All the Commissioners who consented to this arrangement were influential proprietors in the neighbourhood, 2246.

MILLER, JOHN, Engineer to the Glasgow Junction Railway Company . . . . . p. 110
The proposed railway will cross the Clyde at a height of 39 feet above high water mark, with three arches, resting on two piers 15 feet wide each. The clear water-way of the river here is 430 feet; span of centre arch 180 feet. The objections to taking the line above Glasgow are—1st, The increased distance of six miles; 2ndly, That it would not be a thorough line, and so breaks up the traffic, as in witness's opinion, to be of no public benefit, 2276.

HOLLAND, EDWARD, Commander R.N., residing at Truro . . . . . p. 111
Is well acquainted with Falmouth Harbour. The changes he has noticed are new wharfs, and a large quantity of deposit brought down Restronguet Creek from the mines, whereby the shoal off Milor Point is increasing. The corporation of Penryn claim right over the harbour, as lessees of the Bishop of Exeter, 2286——Proposes to make a floating dock in Penryn Creek, a mile below the town. Vessels drawing 13 feet go up to Penryn at high water spring tides. Does not fear any deposit; backwater would keep the channel clear. At Hayle, a small port in St. Ives Bay, 7 feet depth has been gained by sluicing, so that vessels of 200 tons can go in, 2313——Nearly all the population of Penryn has petitioned the Admiralty in favour of the dock, 2320——Is of opinion that the upper part will not fill up. Rise of tide at Penryn 18 feet, 2328——Vessels lie in Carrick Roads at one and a half mile distance. Proposes to have 13 feet in dock, at low water springs, which is now dry, and to dredge the tidal basin and a channel outside. Locks will be placed between capable of admitting the largest steamers, 2356——Falmouth Harbour is efficiently lighted; no buoys are required, 2360.

MACKAIN, DAVID, Secretary and Engineer to the Glasgow Waterworks Company . . . . p. 113
By Acts of 1825 and 1840 the Clyde Trustees are required to maintain the water at a certain level, 2363——The present weir at Stockwell Street Bridge is level with the original bed of the river in 1775. Since that time the channel of the river below has been lowered 9 feet. Spring tides rise 3 feet over the weir, and at that time punts can go up to Rutherglen. Was not aware that Rutherglen was formerly the port of the Clyde. A suit was commenced against the Clyde Trustees by the magistrates of Rutherglen in 1807, to oblige them to remove the weir; it lay in abeyance till 1834, was carried on till 1841, and settled by the present weir being constructed 500 yards higher up the river than the former one. Spring tides swell up to the Water-works two miles above the weir. There has been no navigation at Rutherglen, except for vessels that come through the bridges, since 1345. Immediately below the weir are 12 feet of water at spring tides, owing to dredging, and if the weir were removed, and the Clyde Trustees were so disposed, they might deepen all the way up to Rutherglen, provided they could otherwise secure to the Water-works and certain factories a supply of water at low tides, which they are bound to do by Act of Parliament, or to make compensation, 2402——Witness recommended in 1839 that a supply of water, either through a stone culvert or iron pipe, should be drawn from Carmyle, two miles and a half above Dalmarnock, and a Bill was brought into Parliament for that purpose; but the coal-owners and others objected, and it was lost. The expense of such a work would not exceed 50,000*l.* One objection to removing the weir would be that the hot water from some hundreds of steam-engines and the sewerage of the town would pass to and fro before Glasgow Green and vitiate the air, where the poorer people go to enjoy themselves on a holiday, 2410——In summer and in low states of the tide there is scarcely any perceptible current in the river; at that time the discharge of the Clyde does not exceed 100 cubic feet per second, 2411——Does not admit that if the weir were removed and the river deepened above, as below, a volume of 9 feet of water would sweep up and down every tide, and carry away all such refuse. At present the whole of the water that passes down past the Green at low states of the tide is pure, and the water below the town is extremely offensive, 2413——Since the Clyde has been deepened, the velocity of river in the heaviest floods has increased from four miles and a half to six miles an hour near the Water Works. In heavy land floods, even of eight feet elevation, the tide has no influence on the surface of the river. The valley of the Clyde is composed of such soft alluvial soil, and the river so tortuous, that if the weir were removed and the river deepened so as to cause the tide to increase the rise at the Water Works, the velocity of the current during heavy floods would be so great as to make the upper part of the river quit its bed, and much damage would ensue, 2415——Has not yet calculated the mean discharge of the Clyde, but has got seven years' observations ready to do so. In the lowest state of the river the quantity of water passing the Water Works does not exceed 100 cubic feet per second, while a flood 18

feet in height discharges about 35,000 cubic feet in the same time. The flood of February, 1831, rose 20 feet at the Cranston Hill Works, opposite Rutherglen. Is aware that Telford and Jardine gave it in evidence that if the bottom of the ford at Dalmarnock Bridge be secured, the weir may be taken away at Glasgow Bridge, and the Clyde deepened between those points for about 6 feet, without doing any injury to the Glasgow Water Works; but points out how their statement was qualified, 2417.

FISHER, JOHN, Commander R.N., Principal Harbour Master of the Port of London . . . . p. 117
Has been harbour master 26 years, 2419——The dry bank formed by old London Bridge has been removed and a depth of 11 feet water gained, 2420——Has lighters generally at work in the centre of the river in order to deepen it to 14 feet; the navigable channel has increased in depth slightly from the action of the steam-boats at low-water, 2421——After the shoal in Limehouse Reach the next considerable obstruction is Ham Shelf, which is a great nuisance to Her Majesty's ships that come up to Woolwich; on account of not having given the proper direction to the set of the tide all attempts to clear Woolwich Reach have hitherto failed; a deposit is also formed in front of the dockyard, to remedy which, Mr. Walker, in 1842, recommended that Hook Ness should be cut off, 2422——Fully concurs in Mr. Walker's recommendations in 1842 to the Port of London Committee; attended that survey with Captain Bullock, and approved of the lines for the sides of the river drawn by Mr. Walker, 2427——Is aware of irregularities in the bottom of the river above London Bridge, but his duties are strictly confined below bridge, 2428——Recommended the Navigation Committee to deepen the river from London Bridge downwards, but is not aware why this plan has not been carried out; it rests with the Committee; has pointed out the obstructions, and advised them to be removed, 2430——Formerly people took sand and gravel where they pleased from the river above bridge; in some places they had made holes of 1 foot, in others 5 or 6 feet; this was allowed, under the authority of the Lord Mayor, by the water bailiff, 2433——Excavations are now made under special directions of the water bailiff. Since 1842 there has been considerably more water in certain places, but they have not made a uniform depth in the channel, 2435——Those who are allowed to dig above bridge are directed by the water bailiff where they are to work, 2436——The only difficulties in widening the river would be the expense, and that it would affect many interests in water-side premises, 2443——Those at the side of the river should be called upon to pile and defend their property; jetties, barges, and craft are now run out from different private landing-places; during two-thirds of the tide these barges are aground, stop the free current of the tide, and cause a deposit. The Navigation Committee recommended the removal of all these nuisances, and objected to the manner in which licence has been irregularly given, 2446——No steps have been taken since that Report to prevent the accumulations which have taken place; some of the jetties have been removed, but the most objectionable still remain, 2447——One of these is at Greenwich, run out from Garden Stairs, 2448——To improve the river effectually all these jetties ought to be removed: is of opinion that others might be run out for the public benefit, under proper authority, and of open piles, 2450——No representation has been made by witness since the Report of 1842. Witness removed the pier at Greenwich that he complained of three times as a nuisance, but the Lord Mayor sent him an order to let it remain, 2452——The change of Mayors, &c., is very unfavourable to systematic work on the river; a committee of sailors, under one acknowledged authority, would soon carry out the requisite works. Since London Bridge has been removed the tides have risen higher and fallen out lower than before; in spring-tides it is occasionally 3 feet higher above the Trinity standard than it used to be. Hardly any mud is now found in the river, the steamers wash it all away. On the Whiting Shoal has raised 100 tons of soil a-day: the hard part, resembling plum-pudding stone, is blasted with gunpowder. Trinity dredgers raise 120 tons in 35 minutes, 2472——The clay under the gravel offers great impediments to dredging; expense is the only objection to clearing the river as recommended in the Report of 1842: the present irregular system is directly contrary to that Report: the Trinity Board will only take up material that is fit for ballast, 2503.

Six more vessels sunk within the last year lie between Northfleet Hope and Sea Reach; two near the edge of the Bligh Sand, where the Duc de Nemours grounded in 1843. No immediate measures are taken to remove vessels, some lie 18 months, 2515——The Barking Shelf delayed the Royal Yacht for two hours on her passage to Woolwich; it is of clay, peat, and gravel. Cold Harbour Point, the shoal in Erith Reach, Dagenham Shelf, Bugby's Hole, and the Middle Grounds between Blackwall and Greenwich still remain as in 1842. With the machinery at present in use there would be no difficulty in making the Thames of one uniform depth as recommended in the Report of 1842. The mud still fills up in front of Woolwich dockyard. Agrees with Mr. Walker that the only remedy is to cut off Hook Ness. Either shingle for ballast, or mud dredged up might easily be deposited on the Isle of Dogs or elsewhere. In Woolwich Reach steamers are obliged to wait two hours at times to pass Ham Shelf. If sufficient depth of water, by judicious dredging were maintained on the face of the quays both at Greenwich and elsewhere, there would be no necessity for projecting piers of any sort, 2579.

CUBITT, WILLIAM, Vice President of Inst. of Civil Engineers . . . . . p. 124
Enumerates the different harbours and rivers he has examined professionally and reported upon. Knows of no general rule for improvement applicable to rivers. Crookedness of channel and unevenness of depth are the chief obstructions to the propagation of the tide. Depth in rivers is chiefly due to tides as far up as neap tides reach, above that point to freshes. More to be feared for our harbours from silt brought in from the sea than from detritus brought down by freshes. Has improved the Severn upon two principles; first, as a tidal river by embanking and deepening; secondly, above the influence of the tide by making the river into a series of levels or ponds connected by locks and weirs. By means of four weirs a constant and uniform depth of six feet has been obtained for 20 miles where formerly were only 18 inches, and navigation entirely at a stop; and the same improved depth is nearly completed for 30 miles in the tideway above Gloucester, 2596——If witness were instructed to improve the navigation of the Severn for seagoing vessels he would make a ship canal across the isthmus at Hock Crib with double stop locks at both ends of the cut, leaving the river to go round by Newnham as at present; would also embank many thousand acres of the Nooze Sands just below. If the tide were stopped altogether at Hock Crib it might be better for all the lands above and the navigation below. There are difficulties in controlling the tide; it would be easier to stop it, and pass

the flood water over a weir, 2602——A depth of 15 to 20 feet of quiet water to Gloucester would be much better than having a roaring furious bore all the way. A weir of 3 inches thick would carry off the heaviest floods, and a perfect navigation might be completed to Stourport, from 60 to 70 miles, 2604——The only way to improve Rye Harbour would be to get a good channel out to low-water mark, a distance of 1½ mile; a breakwater or pier is now being carried out there under witness's advice. Scot's Float Sluice has been lately rebuilt under his direction. The tide formerly went up the Rother 15 miles; it was a sluggish stream, a portion was inned out, and by degrees as the land rose more was inned out till they reached the sluice. Before taking the sluice down the embankment must be raised more than three feet. The Rother would silt up, in witness's opinion, if the sluice were taken down. There is no back water, no length of stream to keep it open, nor can any be obtained by deepening the channel, 2618——Has no doubt but that Rye Harbour was formerly deeper; but does not now think it worth the expense that would be requisite to keep it deep. Land covered at neap tides should not be embanked. Would recommend dredging Rye Harbour up to Scot's Float Sluice, regulating and straightening the channel, and carrying down the eastern work to low-water mark in a straight line. Is of opinion that 18 feet at high-water springs may be maintained at Rye, 2665——The proposed railway could not well pass above Scot's Float Sluice without much tunnelling, as alongside the river is a steep cliff; sees no objection to allowing it to cross by a swing bridge, properly constructed at a quarter of a mile above the harbour; the impediments to navigation would be but slight. Is of opinion that many harbours in the kingdom are much improved by engineering. Considers that Government have more power to do evil than do good. A central Government Board, with adequate authority, of the highest possible character, and with sufficient funds at its disposal, if properly administered and without jobbing would certainly be of great benefit to our harbours. It should be a permanent Board of the highest standing, 2651.

Russell, John Scott, Civil Engineer, resident in London . . . . . p. 130
Has examined and reported upon the rivers Dee, Mersey, Clyde, Tay, and others; has made experiments specially with a view to determine the cause of the retardation of the tidal wave, whence it appears that the acceleration of the wave is not due to a large area of water-way, but chiefly to the mean depth of the channel. The tidal wave is propagated according to the same law as a wave of the first order; that is, its velocity is proportioned to the square root of its depth. The result of 10 years' experiments gives that, in 10 feet depth of water, the velocity of the tidal wave would be 12 m. an hour, 20 feet depth 16 m. an hour, 30 feet depth 20 m. an hour, 50 feet depth 26 m. an hour, 70 feet depth 32 m. an hour, 100 feet 34 m. an hour. The same experiments in a channel of the same depth, but shelving gradually to the bottom, reduced the velocity to one-half; the best form for a channel, therefore, is to be as rectangular as possible, consistently with other circumstances. Shallows in a river immediately reduce the velocity of the tidal wave to the rate due to a similar depth of water throughout the channel, whatever velocity it may have in deep water above or below the shoals, 2692——By means of the table contained in the "Report on Waves" in 1844, could, by knowing the velocity of the tidal wave, predict approximatively the depth of water in the channel of the river. A shallow in a river retards the time of the commencement of the flood much more than it does the time of high water. The chief effect of lateral projections is to interfere with the flow of the tidal wave so as to diminish very much the quantity of water that enters without materially affecting the time of its progress. The most notorious case of interruption is in the Dee, where the Dee Company, for the purpose of reclaiming land, have diverted the course of the river. Considers this a case calling for the immediate interference of some controlling power. In 1836 a proprietor run out a small projection from the south bank, which turned the course of the stream nearly at right angles, so as to ruin all the small creeks immediately below it, 2700——The obstruction still exists, and the effect has been a tortuous undefined channel for a distance of 5 miles above Flint Castle. Has no doubt that Chester might be restored to its former eminence as a port, 2709——During the early part of last century, large vessels could go up and ride under the walls of the port; now a vessel of 8 feet draft can only go up at high water spring tides. A very material improvement might be made for 50,000*l*. The entire ruin of the estuary has been caused by the injudicious reclaiming of land to an enormous extent by a Company formed in 1750, under Act of Parliament, 2715——At Flint, the tide rises 33 feet; at Chester, 9½ feet. No doubt that 22 feet water might be obtained to Chester. Chester Bar lies 5 miles from the Point of Ayr, and has 12 feet over it at low water springs. From Ayr Point upwards, where it is now nearly dry, large ships could formerly ride; attributed solely to the injudicious embankments just alluded to, 2731——Had it been done with judgment, land might have been reclaimed, and the navigation unimpaired, 2734.

English, William, Millwright, and Contractor for Dredging . . . . . p. 138
Has been engaged dredging parts of the Thames, and is now at work on the Whiting Shoal, a sort of concrete or plum-pudding stone in Limehouse Reach. Cost of dredging it is 1*s*. a cubic yard; gravel is lifted at 5*d*. per cubic yard, of 26 cwt.; lighterage is a separate charge, varying from 9*d*. to 1*s*. Is not allowed to raise gravel below London Bridge, it is monopolized by the Trinity House for ballast, 2825——No directions given by the water bailiff or other person to deepen a channel in the river, only not to go within 100 feet of the shore on each side. There would be no difficulty, but the expense, in deepening a uniform channel of the river to 6 feet at low water, from London Bridge to Gravesend, 2839——His two engines, of 10-horse power each only, can take up 600 tons daily in 10 hours. Supposing the quantity of soil to be removed from the Thames to be 1¼ million of cubic yards, it could be done in four years, with two engines of 24-horse power each. The Whiting Shoal is about half a mile long; witness is cutting a channel through it of 50 yards in width; the soil is composed of gravel, about 6 inches, then clay, 2 feet; then a substance between a clay and stone, and then stone. Permitted to deepen above bridge 10 feet below low-water mark, except when near a bridge; formerly has dredged to 27 feet in some parts. No difficulty, if required, in dredging the Thames, from London Bridge up to Wandsworth, or from London Bridge downwards to Gravesend, 2880.

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SOUTHWOLD HARBOUR,

AND THE

RIVER BLYTH.

SURVEYED BY JOHN R WRIGHT,

under the direction of

JAMES WALKER, F.R.S.

1840.

The space over which the River used to flow is tinted Green.

Area of the embanked Lands.

Nº of Acres	Cubic Feet of Water excluded.
1504	148, 296, 480
1200	Dunwich, Dingle and Westwood Marshes.
2704	Total Area in Acres.

Mr Walker's Report in 1845. p. 22.

Scale of One Nautic Mile

561 Yards 1014 Yards 1 Nautic Mile

Reduced from Mr Walker's large Plan,
by
E. K. CALVER,
Master and Assistant Surveyor,
H.M.S. Blazer,
1844

THE RIVER BLYTH,

from Blyford Bridge to Halesworth.

by

A. T. CLARKE.

1831.

Continuation on the same Scale

Purdy

HARWICH HARBOUR.

SURVEYED AND DRAWN BY MR E R CALVER R.N.

1841.

PART OF ESSEX

RIVER STOUR

RIVER ORWELL

PART OF SUFFOLK

Harwich Ocy.

Harwich

Naval Yard

Angel Gate Battery

Bath Side Battery

High Light

New Light

Redoubt

300 Acres fit for building Ships, Docks &c.

Navigable Channel

Shotley Pt.

Shotley

Shelly Gate

Bloody Pond

Walton Flat

Walton Ferry

Walton Mortella

Black Granary

Walton Marshes

Walton Creek

Bulls Cliff Mortella

Mortella

Landguard Marshes

Landguard East Beach

Landguard Point to Pillar bearing E.N.E. 3 miles.
to centre of Hollesly Bay Blockhouse N.N.W. 11 miles.

Magnetic Compass

Fagbere Hill

Gristle

Bone

Red

Cod

Station

Red

Black

Black

Black

Black

White

GUARD

ROLLING GROUND

Altar Flats

Altar

Landguard Point

Landguard Fort

Blackmans Head

Beacon Cliff

Cliff Foot Rocks

Ch. d. B.w

PLATTERS

ANDREWS

RAY ISLAND

Low water mark in 1844

Low water mark in 1804

Low water mark in 1752

Cliff Foot Rock

Low water level of ordinary Springs.

Section shewing the Destruction of Beacon Cliff between 1752, 1804 and 1844.

One Sea Mile

The Soundings are expressed in feet. Spring Tides rise 12 Feet. Neap 7.

Shews the limit of Beacon Cliff, Blackmans Head and Landguard Point in 1804.

Limit of Beacon Cliff in 1752.

do do do in 1809.

The Shoals tinted red are proposed to be dredged to a depth of 18 Feet.

Beach end in 1804

Beach in 1844

Low water level of ordinary Springs.

Low water level of ordinary Springs.

0 100 200 300 400 500 1000 2000 3000 Feet

Section shewing the increase of Landguard Point between 1804 and 1844

ENTRANCE of the RIVER CLYDE

From the Survey of

COMMR ROBINSON.R.N.

1839.

Toward Pt Light { 55° 51′ 45″ N. / 4 59 17 W.

3 Sea Miles

SOUNDINGS IN FATHOMS.

THE RIVER CLYDE

From Dumbarton to Carmyle.

BY THOMAS KYLE.

1839.

Continuation on same Scale

SCALE

1 2 Sea Miles

Enlarged Plan
shewing the Projecting Dykes, near
POWGAVIE.

1 Sea Mile

Kingoody
Salmon Batt
Invergowrie Bay
Monorgan Pt
Lord Kinnaird
Colonel Patterson
James Hunter, Esq
Powgavie
Newfoundland Bank
Cross Sand
Birkhall Hall
Kirk

ENTRANCE
OF THE
RIVER TAY
BY COMMR SLATER, R.N.
1833.

High Light F
85 feet high
Low Light F.
65 feet high
Buddon Ness
Gaa Sand
Abertay Sand
Elbow Buoy
Red
Abertay Spit
Gaa Beacon Buoy
White
Fairway Buoy B
1 Sea Mile

ENTRANCE
OF THE
RIVER TAY
BY CAPTN WASHINGTON R.N
Sept.r 1844.

High Light F
85 feet high
Low Light F
65 feet high
Buddon Ness
Gaa Sand
Abertay Sand
Abertay Spit
Red No 3.
Red No 2
Red No 1.
Chop.d B & W.
Gaa Beacon Buoy
Chop.d B & W
Fairway Buoy B
1 Sea Mile

THE
RIVER TAY
SURVEYED BY COMMR SLATER, R.N.
1833.
Buddon Ness High Light { 56° 28′ 7″ N. / 2 44. 53 W.
H.W.F.&C. at Dundee 11h 36m Springs rise 15 feet, Neaps 9.
SOUNDINGS IN FEET.

Dundee
Craigie Hill
Dundee Law
Balgay Hills
Dergo
Kingoody
Invergowrie Bay
Monorgan Pt
Powgavie
Lord Kinnaird
Colonel Patterson
James Hunter, Esq
My Lord Bank
Barkhill Bank
Middle Bank
Newport Lights F
Woodhaven
Wormit Bay
Balmerino Pt
Newfoundland Bank
Cross Sand
Carthagonna Bank
Tide Flows 14 Feet
Errol
John Lee Allen, Esq
Fort Allen
Birkhall Hall
Kirk
Umbrella Tree
School
Pitfour Castle
Camasie Mill
Bambreich Castle
Inchyra
Sir John Richardson
John Lee Allen, Esq
High Haun Bank
Wester Rynd Kirk
R. Earn
David Hay, Esq.
Carpow
Newburgh
Farm
Tayport
Broughty Ferry
Railway
Red Lights F
Craig Lights
Horse Shoe B
Lady Bank
Lady Buoy B
Craig Pier
Monyfieth
Milton
Buddon Ness
Lights F
Gaa Sand
Abertay Sand
Red No 3
Red No 2
Red No 1
Chop.d B & W
Gaa Beacon Buoy
Chop.d B & W
Fairway Buoy B
Tentsmuir Point
R. Eden
Fife Ness
Fife Ness Lights F
Kinnoul Chapel
Kinnoul Tower
Kinfauns Castle
Ben Tower
Kinnoul Kirk
Scotstarvit
Orange I.
Taft Hill
Echo Castle
Ballepburn I
Mouncreiff
Friarton
Lairwell
PERTH
HW 11h 35
10 Cables
6 Sea Miles

Drawn by I. Purdy

RYE HARBOUR.

SURVEYED BY MESSRS SHERRARD & HALL
under the direction of
WM CUBITT F.R.S. M.R.I.A. &c CIVIL ENGINEER
1840,
the Entrance of the Harbour from an eye sketch in 1845.

Scots Float Sluice.

Royal Military Canal to which Rye Harbour is the only navigable outlet, one mile above Scots Float Sluice.

Rother.

River

Playdon Church.

E.t Guildford Church.

The Rother to be crossed by a swing bridge of 20 feet span and 6 feet above high water mark.

Marsh

Canal from Rye to Rother & Hastings to Ashford.

Canal from Rye to Rother & Hastings to Ashford.

R. Tillingham.

RYE.

Church

Sluice

a Baulkham Hole 9 feet depth at Low Water Springs.

Sluice outlet to Rye Harbour in 1838.

North Point Channel.

PROPOSED RAILROAD

Martello Tower No 29.

Winchelsea Sluice.

High Light.

Low Light.

Draft Channel

Debris Sand

Faggot Work

Royal William

Guard Ship.

Old Jetty

Pier Head.

Ship Inn

Custom House

Stone Work

Sand Hills

Camber Station.

Camber Chapel.

Southerlands Kettle Nets

Martello Tower No 28.

River Brede Channel.

Winchelsea Castle. (in ruins)

Beacon

W.r Buoy

W.r Buoy

2.d Buoy B.

Outer Buoy Black.

B.& W.r Chequ.d Buoy.

Camber Detachment or New Buildings

The Nook dry at low water.

Shingle Hills or Ridges.

Dreumaste or Island

R. Brede.

+Winchelsea Church.

The Nook Station or Winchelsea Watch House.

Magnetic Compass

N.

E.

S.

W.

Low Water Line.

Fairlight Head W by S 1/2 S 5 m.

Dungeness Light 2 E S E 7 miles.

High Water Line.

2 4 3 6 6 6 3 6 9 9 9 3 6 12 12 6

0 1/4 1/2 3/4 1

One Nautic Mile 2029 Yards.

The Soundings are in feet.

Spring tides rise in

Rye Harbour 14 feet.

Pier Head 17 feet.

In Rye Bay 23 feet.

High Water at F.& C. XI.h 25.m

Rye Harbour now filled up.

Drawn by I Purdy.

Standidge & Co. Lith. London